AVIATION
AND
AERONAUTICAL ENGINEERING

Building Aeroplanes for the United States Army—Standard H-3

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SPECIAL FEATURES

AERODYNAMICAL PROPERTIES OF THE TRIPLANE
HOW FRANCE TRAINS PILOT AVIATORS
NOMENCLATURE FOR AERONAUTICS
COURSE IN AERODYNAMICS AND AEROPLANE DESIGN
CIVILIAN COOPERATION WITH AVIATION SECTION
SPECIFICATIONS FOR ARMY HYDROAEROPLANES

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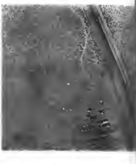

Four Views of the Camp at Columbus, N. M., Taken from an Army Aeroplane

PRESIDENT AND EDITOR
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AVIATION
AND
AERONAUTICAL ENGINEERING

TECHNICAL EDITOR
A. KLEMIN, A.C.G.I. B.Sc., S.M.
Instructor in Aeronautics
Massachusetts Institute of Technology

MANAGING EDITOR
HERBERT M. WILLIAMS, B.S.

Vol. I November 1, 1916 No. 7

THE specifications for Army hydroaeroplanes ("airplanes with float landing gears" is the correct phrase according to the nomenclature of the National Advisory Committee for Aeronautics) published in this issue are unusually complete. The care with which every detail of fuselage (the new nomenclature would use "body") construction has been outlined is the best evidence that the Army knows exactly what it wants. It is a safe assumption that before these specifications were drawn up the information which is drifting into the War Department every day from its foreign attaches has been carefully digested. In short the specifications, it is almost certain, give a complete synopsis of the most approved foreign practice as applied to American conditions.

Designers will have to study carefully all the requirements before they can be sure of meeting them. For example it will not be the simplest thing in the world to design a biplane with say a 9-foot chord which admits of either pilot or passenger hooking on a hoisting gear easily and quickly.

Pilots, too, may have suggestions to offer in the way of improvements. It is an open question, to mention a single minor detail, whether a good many of them would not prefer to have both motor throttles readily accessible to one hand instead of on opposite sides of the body. Both motors could then be throttled practically at the same instant and by removing only one hand from the controls. Throttles on opposite sides of the body however, are undoubtedly easier to install and to keep in repair.

AVIATION AND AERONAUTICAL ENGINEERING will be glad to consider for publication any suggestions or criticisms of these latest War Department specifications. No man or set of men is infallible and the War Department's officers no doubt will welcome any real help in the form of constructive criticism from outside sources.

At the same time civilians interested in aeronautics ought to feel pleased that the War Department has developed its plans so promptly. At the time this is written, it is only sixty days after the signing of the appropriation bill setting aside $13,281,666 for the Aviation Section of the Signal Corps and already $6,000,000 worth of orders for Army airplanes are either in sight or have already been placed. No plans have been put out without mature consideration. The tentative plans for the organization of the Signal Corps, U. S. A., which appeared in the last issue of AVIATION AND AERONAUTICAL ENGINEERING obviously required days of careful thought by experts in military organization. The specifications for land primary and secondary training machines and the new specifications for military airplanes with two engines and float landing gears have all been issued in a clear and precise form admitting of no possible misunderstanding. All this has required constant painstaking labor. The improvements foreshadowed when it was announced that Lieut. Col. George O. Squier had been appointed chief of the Aviation Section are beginning to be seen everywhere.

AT a time when the Army is bending its energies to buying aircraft it would be interesting to know what progress America is making with anti-aircraft guns.

As everyone knows, it is a maxim of war substantially true, that every new weapon of offense soon meets its equal. Today, when war is soaring aloft on wings, new types of anti-aircraft defenses are turning up almost as fast as new aeroplane models are appearing.

In the early days of the war airmen flew at low altitudes to make reconnaissance. Anti-aircraft guns were scarce and ineffective and a flier could pass over hostile troops at no greater height than six or seven hundred feet with comparative safety. Even a rifle bullet with a muzzle velocity of 2,750 feet per second would have to be aimed twenty feet ahead of the pilot of an aeroplane, flying sixty miles an hour at 600 feet altitude, in order to hit the mark. But it did not take long for the European commanders to find out that the combined fire of large bodies of infantry was effective in bringing down aeroplanes.

The fliers met this new danger by ascending to higher altitudes and equipping their machines with powerful telephoto cameras. These cameras take small pictures, as a rule, from which positives can be made and the results projected on a screen. This method reduced reconnaissance in trench warfare almost to an exact science.

Then the "archies" put in their appearance. These anti-aircraft guns fire projectiles weighing from eight to forty pounds 20,000 feet almost vertically upwards. While rifle and machine gun fire is almost wholly ineffective above 6,000 feet the "archies," usually mounted on armored motor cars for mobility, are effective at much greater altitudes. The German guns are of 71 mm. caliber and fire about 20 shots a minute. The shell weighs 11 pounds, and the vertical range is 19,000 feet.

Aerodynamical Properties of the Triplane

By J. C. Hunsaker, Eng.D., and T. H. Huff, S.B.

GENERAL PROBLEM

The demand for increased size and weight of aeroplanes, especially seaplanes, must be met without material increase in the landing speed. On this account the wing loading remains at about 5 pounds per square foot, and for an aeroplane far fourfold the ordinary weight the wing area must be increased in like proportion. Monoplane construction is obviously impractical for such great spread of wings, and even the customary biplane arrangement leads to a span from tip to tip of wings of over 100 feet. The difficulty of handling and housing such a great structure has led to the consideration of wings in a tier of three, or a triplane, to provide the wing area necessary to sustain a great weight at a speed of not more than 50 miles per hour, and at the same time not unduly to extend the span.

The following aerodynamical investigation was undertaken to determine the suitability of the triplane arrangement for weight-carrying as compared with the biplane. It appears that the triplane is not so effective as the biplane, and will require somewhat more power to drive, but with sufficient power the triplane can support nearly the same weight as the biplane at its attitude of maximum lift. The loss is only about 1.1 per cent. At small angles near 4 degrees, for the same lift the triplane requires some 6 per cent more power than the corresponding biplane. At 4 degrees incidence the ratio of lift to resistance is 13.8 for the biplane against 12.8 for the triplane.

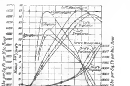

FIG. 1

EXPERIMENTS ON R. A. F. 6 PROFILE

The experiments were conducted in the Wind Tunnel of the Massachusetts Institute of Technology, on wing models made of laminated maple scraped to a profile known as R. A. F. 6* to the nearest 0.005 inch. Each aerofoil was 15.75 inch span by 2.5 inch chord, giving an aspect ratio 6.3. The models were all tested at a wind velocity of 30 miles per hour, air density 0.07608 pounds per cubic foot.

Models were mounted vertically on a spindle, with necessary bracing in a manner described previously.† In every case the effect of the supporting apparatus has been determined by separate tests and subtracted, as well as the effect of such struts or wires as were used to ensure parallelism in the biplane or triplane combinations. The results here recorded, therefore, apply to the bare aerofoils only.

Biplane and triplane models had a constant gap between planes equal to 1.2 times the chord length, and there was no stagger or overhang.

A single aerofoil was first tested as a monoplane to serve as a standard for reference. The lift and resistance, or "drift," are expressed as pounds per square foot wing area per mile hour velocity. The coefficients found are in fair agreement with previous tests upon aerofoils of this section made both at Teddington and at this place. The precision of measurements in our wind-tunnel work is better than 1 per cent; but minor variations in workmanship of models, too slight to be detected, may lead to discrepancies of the order of about 3 per cent between the results of tests on two apparently identical models.‡ The "center of pressure" defined as the intersection of the line of action of the resultant force on the aerofoil with the plane of the chord, has been found by a graphical construction from the observed force components and the moment about the supporting spindle. In the biplane tests the center of pressure is taken in the plane parallel to and midway between the planes of the chords of upper and lower wings, and in the triplane tests the center of pressure is referred to the plane of the chord of the middle wing.

The curves for lift coefficient K_y and drift coefficient K_x, defined by

$$\text{Drift} = K_x S V^2$$
$$\text{Lift} = K_y S V^2$$

(lb.) (sq. ft.) (miles/hour) are plotted in Fig. 1 with the angle of incidence between the chord and wind direction as abscissae. The coefficients calculated as above from the observed forces are plotted to show the consistency of the observations.

FIG. 2

It appears by comparison of the lift curves for the three cases that the triplane and biplane give nearly the same maximum lift at 16 degrees, but that for smaller angles of incidence the triplane lift is appreciably reduced. Confirming previous tests on biplane versus monoplane, we find the lift coefficient for the monoplane superior at angles above zero. The drift coefficient for angles below 12 degrees is not greatly different in the three cases, but at very great angles of incidence, near 16 degrees, the triplane has a materially lower resistance, and has a real advantage in such a "stalling" attitude.

TABLE I

	Monoplane		Biplane		Triplane	
	Actual K_{ym}	Percentage K_{ym}	Actual K_{yb}	Percentage K_{yb}	Actual K_{yt}	Percentage K_{yt}
0	.000486	100	.000432	88.8	.000404	83.0
2	.00103	100	.000864	83.8	.000778	75.4
4	.00147	100	.00123	83.4	.00109	73.7
8	.00218	100	.00181	83.2	.00169	77.4
12	.00278	100	.00241	87.0	.00226	81.2
16	.00277	100	.00273	98.7	.00267	96.1
	L/D	L/D	L/D	L/D	L/D	L/D
0	8.6	100	6.3	73.2	6.1	70.5
2	16.3	100	12.2	74.7	11.4	69.5
4	16.6	100	13.8	82.0	12.8	78.1
8	13.8	100	11.3	81.9	11.1	80.1
12	10.0	100	9.5	95.0	8.8	88.0
16	4.5	100	5.6	124.0	6.5	145.0

The curves of ratio lift/drift bring out the relative effectiveness of the wings. Thus the best L/D ratio is 17 for the monoplane, 13.8 for the biplane, and 12.8 for the triplane. These values refer to small angles of attack corresponding to high flight speed. For a large angle of attack, 16 degrees, the ratios are respectively 4.5, 5.6 and 6.5.

The center-of pressure curves are plotted for biplane and triplane in Fig. 2. It does not appear that center-of pressure motion is changed in character in going from biplane to triplane. In a previous article of *Engineering** we showed that the center-of-pressure motions for the monoplane and for the biplane were nearly identical. The present experiments confirm this conclusion, but the monoplane curve is omitted for the sake of keeping the figure clear.

The table of experimental points, on the preceding page, brings out the relative values of the coefficients in the three cases, taking the monoplane coefficients as standard, and expressing those for the biplane and triplane as a percentage of them.

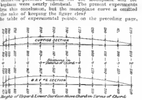

FIG. 3

It may be noted that the drop in lift after passing the maximum is less rapid for the triplane than for the other combinations. The advantage here, if any, is of slight importance, because aeroplanes ordinarily cannot be operated at such great angles of incidence.

EXPERIMENTS ON CURTISS PROFILE

To verify the tests just described the work was repeated for a monoplane, biplane and triplane made from an aerofoil cast in type metal, having a profile similar to that at one time employed by the Curtiss Aeroplane Company. This profile differs from the R. A. F. 6, shown in Fig. 3, by the thickness of the edges.

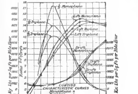

FIG. 4

These Curtiss aerofoils were made of the same over-all dimensions as the R. A. F. 6, arranged, as before, with gap 1.2 times chord, and tested in an identical manner. The results for the monoplane, biplane and triplane are shown in Fig. 4. These curves are of the same general character as those for R. A. F. 6 given in Fig. 1. We have then confirmation of the conclusions that:

1. The maximum lift of the triplane is very nearly as great as that of the biplane;
2. At angles of incidence between 2 degrees to 12 degrees the lift and ratio L/D of the triplane are materially less than the corresponding values for the biplane.

Applied to an aeroplane, we should expect to obtain about

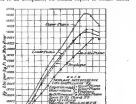

FIG. 5

the same landing speed on given wing area, whether the biplane or triplane arrangement were used. The maximum speed for given engine power would, however, be less for the triplane on account of lower L/D ratio at small angles.

INTERFERENCE

Experiments were next undertaken to determine the distribution of load upon the three wings of the triplane made of aerofoils of R. A. F. 6 profile. A special apparatus was

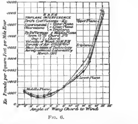

FIG. 6.

designed by which two wings of the combination could be supported independently in their proper attitude, while the remaining one was attached to the balance, and its characteristic coefficients found by experiment. It was convenient to measure the lift and resistance components for the upper wing and for the lower wing as influenced by the others, and then to find the forces on the middle wing by subtraction from the values previously found for the complete triplane.

The results are shown by the curves of Figs. 5, 6 and 7.†

* Technical Report of the Advisory Committee for Aeronautics, 1912-13, London.

† "Stable Biplane Arrangements," Engineering, January 7, 1916, page 1.

‡ Smithsonian Miscellaneous Collections, vol. 62, No. 4, "Characteristic Curves for Wing Section, R. A. F. 6."

* See Engineering, January 7, 1916, page 1.

† Lift/drift plotted from faired curves.

It appears that the upper wing is very much the most effective of the three, and that the middle wing is the least effective. The coefficients for the lower wing are very nearly those for the three in combination as a triplane

To estimate the lift on each wing for use in structural design of the wing girder, we give below a table showing the lift and ratio lift/drift of each wing in terms of the corresponding values for the middle wing taken as unity

TABLE 2.

Angle of Incidence	Lift Upper	Lift Middle	Lift Lower	L/D Upper	L/D Middle	L/D Lower
0	2.08	1.0	1.82	3.63	1.0	2.30
2	2.14	1.0	1.76	3.19	1.0	2.13
4	1.91	1.0	1.64	2.50	1.0	1.68
8	1.66	1.0	1.36	1.49	1.0	1.37
12	1.66	1.0	1.31	1.30	1.0	1.24
16	1.49	1.0	1.26	1.23	1.0	1.17

The very poor lift of the middle wing must be caused by interference with the free flow of air due to the presence of the upper and lower wings. It would be reasonable to suppose that the middle wing influences the lower wing to the same degree that the upper wing of a biplane influences the lower wing, and that it influences the upper wing of the triplane to the same degree that the lower wing of a biplane influences the upper wing of that combination. Consequently, if this reasoning hold, we should expect the sum of the observed lifts on the upper and lower wings of the triplane to be equal to the observed lift on the biplane R. A. F. 6 previously tested.

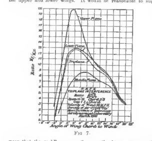

FIG 7

The observed biplane lift coefficient and the hypothetical biplane lift coefficient, calculated from the sum of the lifts on upper and lower wings of the triplane are plotted in Fig 8. It appears that for all angles below the critical angle where the lift coefficient drops off, the discrepancy is slight.

For a given wing profile there is a definite angle of no lift. Our method of measuring wind direction in these experiments admits of a precision of about 0.25 degrees. Since all of our curves are plotted on angle of incidence as abscissae, they may be moved bodily to right or left 0.2 degrees and still express the results within the limit of precision of the experiments. It has been found necessary to correct the lift curve for the hypothetical biplane in this manner by moving it to the right 0.25 degrees in order to give the same angle of no lift.

The lift coefficient at 16 degrees, the critical angle, is very difficult to determine with any certainty on account of the unstable nature of the fluid motion at this angle. Violent eddy making begins here, and the balance tends to oscillate unless heavily damped. Excepting at the critical angle, the lift coefficients observed for the biplane and calculated for a similar biplane from the lift on upper and lower wings of triplane, are in such good agreement that we conclude that the curves of Fig. 8 furnish the check and verification desired.—*Engineering*

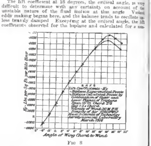

FIG 8

How France Trains Pilot Aviators

By a Sergeant of the American Escadrille at Verdun

The following article was secured by AVIATION AND AERONAUTICAL ENGINEERING *from a sergeant of the American Escadrille. In the letter that accompanied the article he wrote:—*

"It strikes me that the subject ought to be of interest, especially since America is starting out to build an aerial fleet and to train pilots to man it. If it is acceptable, please run it as anonymous. Sorry I could not get the enclosed typewritten, but there are no facilities around where the biggest battle in the world has been fought.

*"I do not get a chance to see much of it, for I'm on a fighting machine and the sky is my province. We fly so high that ground details are lacking. Where the battle has raged there is a broad, browned land. It is a great strip of murdered nature. Trees, houses and roads have been blasted completely away. The shell holes are so numerous that they blend into each other and cannot be seen. It looks as if shells fell by the thousands every second. There are spurts of smoke at nearly every foot of the brown areas and a thick pall of mist covers it all. There are but holes where the trenches ran, and when one thinks of the poor devils crouching in their inadequate shelters under such a hurricane of flying metal it increases one's respect for the staying powers of modern man. It's terrible to watch and I feel sad every time I look down. The noise of the motor drowns all other sound, and so the battle passes in silence. The only shooting we hear is the tut-tut-tut of our own or enemy plane's machine guns when fighting is at close quarters. * * * The Germans, I must admit, have an excellent aerial fleet. * * *"*

France now has thousands of men training to become military aviators, and the flying schools, of which there are a very great number, are turning out pilots at an astounding rate.

The process of training a man to be a pilot aviator naturally varies in accordance with the type of machine on which he takes his first instruction, and so the methods of the various schools depend on the apparatus upon which they teach an "élève pilote," as an embryonic aviator is called, to fly.

In the case of the larger biplanes, a student goes up in a dual control aeroplane, accompanied by an old pilot, who, after first taking him on many short trips, then allows him part, and later full control, and who immediately corrects any false moves made by him. After that, short, straight line flights are made alone in a smaller powered machine by the student, and, following that, the training goes on by degrees to the point where a certain mastery of the apparatus is attained. Then follows the prescribed "stunts" and voyages necessary to obtain the military brevet.

Photo by Bain News Service.

GERMAN GOTHA BIPLANE WITH MORANE-SAULNIER TYPE BODY AND TAIL SURFACES

TRAINING FOR FLYING PURSUIT AEROPLANES

The method of training a pilot for a small fast "avion de chasse," as a fighting aeroplane is termed, is quite different, and as it is the most thorough and interesting I will take that course up in greater detail.

The man who trains for one of these machines never has the advantage of going first into the air in a double command aeroplane. He is alone when he first leaves the earth, and so the training preparatory to that stage is very carefully planned to teach a man the habit of control in such a way that all the essential movements will come naturally when he first finds himself face to face with the new problems the air has set for him. In this preparatory training a great deal of weeding out is effected, for a man's aptitude for the work shows up, and unless he is by nature especially well fitted he is transferred to the division which teaches one to fly the larger and safer machines.

First of all, the student is put on what is called a roller. It is a low powered machine with very small wings. It is strongly built to stand the rough wear it gets, and no matter how much one might try it could not leave the ground. The apparatus is jokingly and universally known as a "Penguin," both because of its humorous resemblance to the quaint arctic birds and its inability in common with them to do any flying. A student makes a few trips up and down the field in a double control Penguin, and learns how to steer with his feet. Then he gets into a single seated one and, while the rapidly whirling propeller is pulling him along, tries to keep the Penguin in a straight line. The slightest mistake or delayed movement will send the machine skidding off to the right or left, and sometimes, if the motor is not stopped in time, over on its side or back. Something is always being broken on a Penguin, and so a reserve flock is kept at the side of the field in order that no time may be lost.

After one is able to keep a fairly straight line, he is put on a Penguin that moves at a faster rate, and after being able to handle it successfully passes to a very speedy one, known as the "rapid." Here one learns to keep the tail of the machine at a proper angle by means of the elevating lever, and to make a perfectly straight line. When this has been accomplished and the monitor is thoroughly convinced that the student is absolutely certain of making no mistakes in guiding with his feet, the young aviator is passed on to the class which teaches him how to leave the ground. As one passes from one machine to another one finds that the foot movements must be made smaller and smaller. The increased speed makes the machine more and more responsive to the rudder, and as a result the foot movements become so gentle when one gets into the air that they must come instinctively.

FIRST FLIGHTS ALONE

The class where one will leave the ground has now been reached, and an outfit of leather clothes and casque is given to the would-be pilot. The machines used at this stage are low-powered monoplanes of the Bleriot type, which, though being capable of leaving the ground, cannot rise above a few feet. They do not run when the wind is blowing or there are any movements of air from the ground, for though a great deal of balancing is done by correcting with the rudder, the student knows nothing of maintaining the lateral stability, and if caught in the air by a bad movement would be apt to sustain a severe accident. He is now only to learn how to take the machine off the ground and hold it at a low line of flight for a few moments.

For the first time one is strapped into the seat of the machine, and this continues to be the case from this point on. The motor is started, and one begins to roll swiftly along the ground. The tail is brought to an angle slightly above a straight line. Then one sits tight and waits. Suddenly the motion seems softer, the motor does not roar so loudly, and the ground is slipping away. The class standing at the end of the line looks far below, the individuals are very small, but though you imagine you are going too high, you must not push to go down more than the smallest fraction, or the machine will dive and smash. The small push has brought you down with a bump from a seemingly great height. In reality you have been but three feet off the ground. Little by little the student becomes accustomed to leaving the ground, for these short hop-skip-and-jump flights, and has learned how to steer in the air.

If he has no bad smash-ups he is passed on to a class where he rises higher, and is taught the rudiments of landing. If, after a few days, that act is reasonably performed and the young pilot does not land too hard, he is passed to the class where he goes about sixty feet high, maintains his line of flight for five or six minutes and learns to make a good landing from that height. He must by this time be able to keep his machine on the line of flight without dipping and rising, and the landings must be uniformly good. The instructor takes a great deal of time showing the student the proper line of descent, for the landings must be perfect before he can pass on.

Photo by Bain News Service.

THE NARROW BODY CONSTRUCTION OF THIS BRITISH DEPERDUSSIN MONOPLANE SAVES MUCH WEIGHT.

Now comes the class where the pilot rises three or four hundred feet high and travels for over two miles in a straight line. Here he is taught how to combat air movements and maintain lateral stability. All the flying up to this point has been done in a straight line, but now comes the class where one is taught to turn. Machines in this division are almost as high powered as a regular flying machine, and can easily climb to two thousand feet. The turn is at first very wide, and then, as the student becomes more confident, they are done more quickly, and while the machine leans at an angle that would frighten one if the training in turning had not been gradual. When the pilot can make reasonably close right and left turns, he is told to make figure eights. After doing this well he is sent to the real flying machines.

There is nothing in the way of a radical step from the

turns and figure eights to the real flying machines. It is a question of becoming at ease in the better and faster aeroplanes, taking greater altitudes, making little trips, perfecting landings and mastering all the movements of correction that one is forced to make. Finally one is taught how to shut off and start one's motor again in the air, and then to go to a certain height, shut off the motor, make a half-turn while dropping and start the motor again. After this, one climbs to about two thousand feet and, shutting off the motor, spirals down to within five hundred feet of the ground.

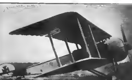

Photo by Bain News Service

THE STRUTS IN THIS GERMAN AGO BIPLANE APPEAR TO BE UNTAPERED. IT MIGHT EASILY BE MISTAKEN FOR A BRITISH SCOUT

When that has been practiced sufficiently, a registering altitude meter is strapped to the pilot's back and he essays the official spiral, in which one must spiral all the way to earth with the motor off, and come to a stop within a few yards of a fixed point on the aviation grounds. After this, the student passes to the voyage machines which are of almost twice the power of the machine used for the short trips and spirals.

TESTS FOR THE MILITARY BREVET

There are three voyages to make. Two consist in going to designated towns an hour or so distant and returning. The third voyage is a triangle. A landing is made at one point and the other two points are only necessary to cross. In addition, there are two altitudes of about seven thousand feet each that one has to attain either while on the voyages or afterwards.

The young pilot has not, up to this point, had any experiences on trips, and there is always a sense of adventure in starting out over unknown country with only a roller map to guide one and the gauges and controls, which need constant attention, to distract one from the reading of the chart. Then, too, it is the first time that the student has flown free and at a great height over the earth, and his sense of exultation at navigating at will the boundless sky causes him to imagine he is a real pilot. True it is that when the voyages and altitudes are over, and his examinations in aeronautical sciences passed, the student becomes officially a "pilote aviateur," and he can wear two little gold woven wings on his collar to designate his capacity, and carry a winged propeller emblem on his arm, but he is not ready for the difficult work of the front, and before he has time to enjoy more than a few days' rest he is sent to a school of "perfectionment." There the real, serious and thorough training begins.

Schools where the pilots are trained on the modern machines, "Ecoles de Perfectionment," as they are called, are usually an annex to the centers where the soldiers are taught to fly, though there are one or two camps that are devoted exclusively to giving advanced instruction to aviators who are to fly the "Avions de Chasse," or fighting machines. When the aviator enters one of these schools he is a breveted pilot, and he is allowed a little more freedom than he enjoyed during the time he was learning to fly.

He now takes up the Morane monoplane. It is interesting to note that the German Fokker is practically a copy of this machine. After flying for a while on a low powered Morane and having mastered the landing, the pilot is put on a new, higher powered model of the same make. He has a good many hours of flying, but his trips are very short, for the whole idea is to familiarize one with the method of landing. The Blériot has a landing gear that is elastic in action, and it is easy to bring to earth. The Nieuport and other makes of small, fast machines for which the pilot is training have a solid wheel base, and good landings are much more difficult to make. The Morane pilot has the same practices climbing to small altitudes around eight thousand feet and picking his landing from that height with motor off. When he becomes proficient in flying the single and double place types

Photo by Bain News Service

FRENCH MORANE-SAULNIER PARASOL. IT HAS NO FIXED STABILIZER OR FIN, AND THE CONCENTRATION OF WEIGHTS MAKES IT A MACHINE FOR ACCOMPLISHED PILOTS ONLY

he leaves the school for another, where shooting with machine guns is taught.

This course in shooting familiarizes one with various makes of machine guns used in aeroplanes, and one learns to shoot at targets from the air. After two or three weeks the pilot is sent to another school of combat.

TRICK FLYING AND DOING STUNTS

These schools of combat are connected with the "Ecoles de Perfectionment" with which the pilot has finished. In the combat school he learns battle tactics, how to fight singly and in fleet formation, and how to extract himself from a too dangerous position. Trips are made in squadron formation and sham battles are effected with other "escadrilles," as the smallest unit of an aerial fleet is called. For the first time the pilot is allowed to do fancy flying. He is taught how to loop the loop, slide on his wings or tail, go into corkscrews and, more important, to get out of them, and he is encouraged to try new stunts.

Finally the pilot is considered well enough trained to be sent to the reserve where he waits his call to the front. At the reserve he flies to keep his hand in, practices on any new make of machine that happens to come out or that he may be put on in place of the Nieuport, and receives information regarding old and new makes of enemy aeroplanes.

At last the pilot receives his call to the front, where he takes his place in some established or newly formed "escadrille." He is given a new machine from the nearest aeroplane reserve center, and he then begins his active service in the war which, if he survives the course, is the best school of them all.

German Dirigible Had Aluminum Gondola

The gondola of the dirigible found on the east coast of England after the raid of September 2 was brought to the Admiralty and was examined by experts. Attached to the gondola were several thousand feet of aluminum wire. The gondola, which was about seven feet in length and five feet high, was made entirely of aluminum. There were several windows made of mica, and the car was fitted with a clock, altitude gauge, electric torch, and telephone. On the floor of the car was found a straw mattress.

Persons in England who find relics of raiders are under orders to turn them over to the authorities so that any knowledge that may be of military importance may be gleaned from the wreckage. Those who bring in their prized souvenirs are assured that any pieces that do not prove valuable to the authorities will be returned to them.

Nomenclature for Aeronautics

Prepared by the National Advisory Committee for Aeronautics

For the information of those interested in aeronautics, the following nomenclature has been prepared as a guide with a view to eliminating the duplication of terms, the erroneous use of terms, and confusion of terms, and with a view to defining the principal terms which have come into use in the development of aeronautics. In the preparation of this nomenclature only those terms have been defined which are new and peculiar to this subject.

Aeronautical Nomenclature

AEROFOIL. A thin wing-like structure flat or curved designed to obtain reaction upon its surfaces from the air through which it moves.

AEROPLANE. See airplane.

AILERON. A movable auxiliary surface used for the control of rolling motion—i. e., rotation about the fore and aft axis.

AIRCRAFT. Any form of craft designed for the navigation of the air—airplanes, balloons, dirigibles, helicopters, kites, kite-balloons, ornithopters, gliders, etc.

AIRPLANE. A form of aircraft heavier than air which has wing surfaces for sustentation, with stabilizing surfaces, rudders for steering, and power plant for propulsion through the air. The landing gear may be suited for either land or water use.

Pusher.—A type of airplane with the propeller or propellers in rear of the wings.

Tractor.—A type of airplane with the propeller or propellers in front of the wings.

AIR SPEED METER. An instrument designed to measure the velocity of an aircraft with reference to the air through which it is moving.

ALTIMETER. An instrument mounted on an aircraft to continuously indicate its height above the surface of the earth.

ANEMOMETER. An instrument for measuring the velocity of the wind or air currents with reference to the earth or some fixed body.

ANGLE.

Of attack.—The angle between the direction of the relative wind and the chord of an aerofoil or the fore and aft axis of a body.

Critical.—The angle of attack at which the lift is a maximum.

Gliding.—The angle the flight path makes with the horizontal when flying in still air under the influence of gravity alone.

ASPECT RATIO. The ratio of spread to chord of an aerofoil.

AXES OF AN AIRCRAFT. Three fixed lines of reference, usually centroidal and mutually perpendicular.

The principal longitudinal axis in the plane of symmetry, usually parallel to the axis of the propeller, is called the fore and aft axis (or longitudinal axis); the axis perpendicular to this in the plane of symmetry is called the vertical axis, and the third axis, perpendicular to the other two, is called the athwartship axis (or transverse or lateral axis). In mathematical discussions the first of these axes is called the X axis, the second the Z axis, and the third the Y axis.

BALLONET. A small balloon within the interior of a balloon or dirigible for the purpose of controlling the ascent or descent and for maintaining pressure on the outer envelope to prevent deformation. The ballonet is kept inflated with air at the required pressure, under the control of a blower and valves.

BALLOON. A form of aircraft comprising a gas bag and a car, whose sustentation depends on the buoyancy of the contained gas which is lighter than air.

Captive.—A balloon restrained from free flight by means of a cable attaching it to the earth.

Kite.—An elongated form of captive balloon fitted with tail appendages to keep it headed into the wind, and deriving increased lift due to its axis being inclined to the wind.

BANK. To incline an airplane laterally—i. e., to rotate it about the fore and aft axis. Right bank is to incline the airplane with the right wing down.

BANKING INDEX. See Inclinometer.

BAROGRAPH. An instrument used to record variations in barometric pressure. In aeronautics the charts on which the records are made are prepared to indicate altitudes directly instead of barometric pressure.

BIPLANE. A form of airplane in which the main supporting surface is divided into two parts, one above the other.

BODY OF AN AIRPLANE. A structure, usually inclosed, which contains in a stream line housing the power plant, fuel, passengers, etc.

CABRÉ. A flying attitude in which the angle of attack is greater than normal; tail down; down by the stern—tail low.

CAMBER. The convexity or rise of a curve of an aerofoil from its chord, usually expressed as the ratio of the maximum departure of the curve from the chord as a fraction thereof. "Top Camber" refers to the top surface of an aerofoil, and "Bottom Camber" to the bottom surface; "Mean Camber" is the mean of these two.

CAPACITY.

Lifting.—The maximum flying load of an aircraft.

Carrying.—Excess of the lifting capacity over the dead load of an aircraft, which latter includes structure, power plant, and essential accessories.

CARRYING CAPACITY. See Capacity.

CENTER. The point in which a set of effects is assumed to be accumulated producing the same effect as if all were concentrated at this point.

Of buoyancy.—The center of gravity of the fluid displaced by the floating body.

Of pressure of an aerofoil.—The point on the chord of an element of an aerofoil, prolonged if necessary, through which at any instant the line of action of the resultant air force passes.

Of pressure of a body.—The point of the axis of a body, prolonged if necessary, through which at any instant the line of action of the resultant air force passes.

CHORD.

Of an aerofoil section.—A right line tangent to the under curve of the aerofoil section at the front and rear.

Length.—The length of the chord is the length of the aerofoil section projected on the chord, extended if necessary.

CONTROLS. A general term applying to the means provided for operating the devices used to control speed, direction of flight, and attitude of an aircraft.

CRITICAL ANGLE. See Angle, Critical.

DÉCALAGE. An increase in the angular setting of the chord of an upper wing of a biplane with reference to the chord of the lower wing.

DEVELOPED AREA OF A PROPELLER. A layout of the area of a propeller blade designed to represent the total area of the driving face, in which the elements of area are developed as if unfolded onto the plane of the drawing (necessarily an approximation on definite assumptions, as no true development of the helix can be made).

DIRIGIBLE. A form of balloon, the outer envelope of which is of elongated form, provided with a propelling system, car, rudders, and stabilizing surfaces.

Nonrigid.—A dirigible whose form is maintained by the pressure of the contained gas assisted by the car-suspension system.

Rigid.—A dirigible whose form is maintained by a rigid structure contained within the envelope.

Semirigid.—A dirigible whose form is maintained by means of its attachment to an exterior girder construction containing the car.

DISK AREA OF A PROPELLER. The total area of the disk swept by the propeller tips.

DIVING RUDDER. See Elevator.

DOPE. A general term applied to the material used in treating the cloth surface of air-plane members to increase strength, produce tautness, and act as a filler to maintain air-tightness; usually of the cellulose type.

DRAG. The total resistance to motion through the air of an aircraft—i. e., the sum of the drift and head resistance.

DRIFT. The component of the resultant wind pressure on an aerofoil or wing surface parallel to the air stream attacking the surface.

ELEVATOR. A hinged surface for controlling the longitudinal attitude of an aircraft—i. e., its rotation about the athwartship axis.

ENGINE, RIGHT OR LEFT HAND. The distinction between a right-hand and a left-hand engine depends on the rotation of the output shaft, whether this shaft rotates in the same direction as the crank or not. A right-hand engine is one in which when viewed from the output shaft end, the shaft is seen to rotate anticlockwise.

ENTERING EDGE. The foremost part of an aerofoil.

FINS. Small planes on aircraft to promote stability; for example, vertical tail fins, horizontal tail fins, skid fins, etc.

FLIGHT PATH. The path of the center of gravity of an aircraft with reference to the air.

FLOAT. That portion of the landing gear of an aircraft which provides buoyancy when it is resting on the surface of the water.

FUSELAGE. See Body.

Gap. The distance between the projections on the vertical axis of the entering edges of an upper and lower wing of a biplane.

Glide. To fly without power.

Glider. A form of aircraft similar to an airplane but without any power plant.

When utilized in variable winds it makes use of the soaring principles of flight and is sometimes called a soaring machine.

Gliding angle. See Angle, Gliding.

Guy. A rope, chain, wire or rod attached to an object to guide or steady it, such as guys to wing, tail, or landing gear.

Head resistance. The total resistance to motion through the air of all parts of an aircraft not a part of the main lifting surface. Sometimes termed parasite resistance.

Helicopter. A form of aircraft whose support in the air is derived from the vertical thrust of large propellers.

Inclinometer. An instrument for measuring the angle made by any axis of an aircraft with the horizontal.

Keel plane area. The total effective area of an aircraft which acts to prevent skidding or side slipping.

Kite. A form of aircraft without other propelling means than the towline pull, whose support is derived from the force of the wind moving past its surface.

Kite balloon. See Balloon, kite.

Landing gear. The under structure of an aircraft designed to carry the load when resting on or running on the surface of the land or water.

Lateral stability. See Stability, lateral.

Leading edge. See Entering edge.

Leeway. The angular deviation from a course over the earth due to cross currents of wind.

Lift. The component of the force due to the air pressure on an aerofoil resolved perpendicular to the flight path in a vertical plane.

Lift bracing. See Stay.

Lifting capacity. See Capacity, lifting.

Load, full. See Capacity, lifting.

Weight of pay load.—See Capacity, carrying.

Loading. See Wing loading.

Longitudinal. A fore-and-aft member of the framing of an airplane body or of the floats, usually continuous across a number of points of support.

Longitudinal stability. See Stability.

Metacenter. The point of intersection of a vertical line through the center of gravity of the fluid displaced by a floating body when it is tipped through a small angle from its position of equilibrium and the inclined line which was vertical through the center of gravity of the body when in equilibrium. There is, in general, a different metacenter for each type of displacement of the floating body.

Monoplane. A form of airplane whose main supporting surface is disposed as a single wing on each side of the body.

Motor. See Engine.

Nacelle. See Body.

Natural stability. See Stability.

Nose dive. A dangerously steep descent, head on.

Ornithopter. A form of aircraft deriving its support and propelling force from flapping wings.

Pitot tube. A tube with an end open square to the fluid stream, used as a detector of an impact pressure. More usually associated with a concentric tube surrounding it, having perforations normal to the axis for indicating static pressure. The velocity of the fluid can be determined from the difference between the impact pressure and the static pressure. This instrument is often used to determine the velocity of an aircraft through the air.

Propeller.

Developed area of.—See Developed area of a propeller.

Disk area of.—See Disk area of a propeller.

Right hand.—One in which the helix is right handed.

Pusher. See Airplane.

Pylon. A marker of a course.

Race of a propeller. The air stream delivered by the propeller.

Rib. See Wing.

Right (or left) hand.

Engine.—See Engine.

Propeller.—See Propeller, right hand.

Rigid dirigible. See Dirigible, rigid.

Rudder. A hinged or pivoted surface, usually more or less flat or stream lined, used for the purpose of controlling the attitude of an aircraft about its vertical axis when in motion.

Side slipping. Sliding toward the center of a turn. It is due to excessive amount of bank for the turn being made and is the opposite of skidding.

Skidding. Sliding sideways in flight away from the center of the turn. It is usually caused by insufficient banking in a turn, and is the opposite of side slipping.

Skids. Long wooden or metal runners designed to prevent nosing of a land machine when landing or to prevent dropping into holes or ditches in rough ground. Generally designed to function should the wheels collapse or fail to act.

Slip. This term applies to propeller action and is the difference between the actual velocity of advance of an aircraft and the speed calculated from the known pitch of the propeller and its number of revolutions.

Soaring machine. See Glider.

Spread. The maximum distance laterally from tip to tip of an airplane wing.

Stability. The quality of an aircraft in flight which causes it to return to a condition of equilibrium when meeting a disturbance.

(This is sometimes called "Dynamical stability.")

Directional.—Stability with reference to the vertical axis.

Inherent.—Stability of an aircraft due to the disposition and arrangement of its fixed parts.

Lateral.—Stability with reference to the longitudinal (or fore and aft) axis.

Longitudinal.—Stability with reference to the lateral (or athwartship) axis.

Stabilizer. See Fins.

Mechanical.—Any automatic device designed to secure stability in flight.

Stagger. The amount of advance of the entering edge of the upper wing of a biplane over that of the lower. It is considered positive when the upper surface is forward.

Stalling. A term describing the condition of an airplane which from any cause has lost the relative speed necessary for steerageway and control.

Statoscope. An instrument to detect the existence of a small rate of ascent or descent, principally used in ballooning.

Stay. A wire, rope, or the like used as a tie piece to hold parts together, or to contribute stiffness; for example, the stays of the wing and body trussing.

Step. A break in the form of the bottom of a float.

Stream line flow. A term in hydromechanics to describe the condition of continuous flow of a fluid, as distinguished from eddying flow, where discontinuity takes place.

Stream line shape. A shape intended to avoid eddying or discontinuity and to preserve stream line flow, thus keeping resistance to progress at a minimum.

Strut. A compression member of a truss frame; for instance, the vertical members of the wing truss of a biplane.

Sweep back. The horizontal angle between the lateral (athwartship) axis of an airplane and the entering edge of the main planes.

Tail. The rear portion of an aircraft, to which are usually attached rudders, elevators, and fins.

Tail fins. The vertical and horizontal surfaces attached to the tail, used for stabilizing.

Thrust deduction. Due to the influence of the propellers, there is a reduction of pressure under the stern of the vessel which appreciably reduces the total propulsive effect of the propeller. This reduction is termed "Thrust deduction."

Tractor. See Airplane.

Trailing edge. The rearmost portion of an aerofoil.

Triplane. A form of airplane whose main supporting surfaces are divided into three parts, superposed.

Truss. The framing by which the wing loads are transmitted to the body; comprises struts, stays, and spars.

Velometer. See Air Speed meter and anemometer.

Vol piqué. See Nose dive.

Vol plané. See Glide.

Wake gain. Due to the influence of skin friction, eddying, etc., a vessel in moving forward produces a certain forward movement of the fluid surrounding it. The effect of this is to reduce the effective resistance of the hull, and this effect due to the forward movement of the wake is termed "the wake gain."

In addition to this effect the forward movement of this body of fluid reduces the actual advance of the propeller through the surrounding medium, thereby reducing the propeller horsepower.

Warp. To change the form of the wing by twisting it, usually by changing the inclination of the rear spar relative to the front spar.

Wings. The main supporting surfaces of an airplane.

Wing loading. The weight carried per unit area of supporting surface.

Wing rib. A fore and aft member of the wing structure used to support the covering and to give the wing section its form.

Wing spar. An athwartship member of the wing structure resisting tension and compression.

Yaw. To swing off the course about the vertical axis owing to gusts or lack of directional stability.

Angle of.—The temporary angular deviation of the fore and aft axis from the course.

Course in Aerodynamics and Aeroplane Design*

By Alexander Klemin, A.C.G.I., B.Sc., S.M.

Instructor in Aeronautics, Massachusetts Institute of Technology, Member of the Aeronautical Society of Great Britain and Ireland,

and

T. H. Huff, S.B.

Instructor in Aeronautics, Massachusetts Institute of Technology

PART 1—SECTION 7

Study of Pressure Distribution

For general purposes, a knowledge of lift, drag and the position of the vector of resultant force at various angles of incidence is as much aerodynamical data as the designer requires with reference to a wing section. But an investigation of pressure distribution bears directly on an understanding of the following important points:

1. The variation of stresses in the covering fabric of a wing due to the unequal distribution of pressures.
2. The great efficiency of a cambered surface as compared with a flat plate.
3. The analysis of the forces at play and their exact bearing on efficiency, and on the position of the resultant vector.
4. The relative importance and the inter dependence of the two surfaces of a wing.
5. The effects of varying aspect ratio.
6. The variation of lift and drift with speed and size of model.

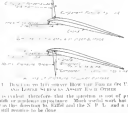

Fig. 1. Diagram to Illustrate How the Forces On Upper and Lower Surfaces Assist Each Other

It is evident therefore that the question is not of purely scientific or academic importance. Much useful work has been done in this direction by Eiffel and the N. P. L., and a great deal still remains to be done.

Methods of Obtaining Pressure Distribution

The mapping of pressure distribution is a lengthy process requiring numberless readings. It is fully described in the N. P. L. reports, and we shall only summarize briefly the methods employed.

Holes of 1/4 inch diameter are drilled in the wing where required, normally to its surface, and are plugged with plasticine, except the one under observation. The hole in use is connected by a length of very thin hypodermic syringe tubing, too small to cause disturbance, with a three-way cock. A pitot and static pressure tube is placed in the channel where the flow is undisturbed by the presence of the model. The static pressure tube is permanently connected to one arm of the usual manometer; the other arm can be connected alternately by means of the three way cock either to the pitot tube or to the hole drilled in the wing section.

The manometer can be thus made to read either the velocity head of the wind, or the difference in pressure between the static pressure of the channel, and the pressure on the wing at the point considered; and a direct comparison between these two quantities is immediately possible. Great care has to be exercised in obtaining values of pressure distribution which correspond to a constant value of the wind velocity, and in maintaining the same direction of the pitot tube relative to the wing.

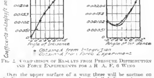

Fig. 2. Comparison of Results from Pressure Distribution and Force Experiments for a R. A. F. 6 Wing

Over the upper surface of a wing there will be suction on the lower surface pressure, and we shall indicate the exact distribution in this section. In Fig. 1, the suction force normal to the upper surface, and the pressure force normal to the lower surface, are represented diagrammatically for the same position on the chord. If these forces are resolved along the line of the relative wind and perpendicular to it, we see that they add up to give a force upwind and lift. At other points along the chord these forces may oppose one another or give

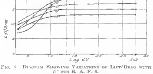

Fig. 3. Diagram Showing Variations of Lift/Drag with lV for R. A. F. 6.

a force downwind. An elaborate method of graphical integration for pressure forces has been devised by the N. P. L., but their integration was normal and perpendicular to the chord. Such summations, if taken as giving lift and drag, involve errors except at very small angles.

Comparison of Results from Pressure Distribution and from Force Experiments

In sections 2 and 3 of the course, we have divided the forces acting on a wing into two classes—density or turbulence forces, and skin friction forces. A study of pressure diagrams en-

* This course commenced in the August 1, 1916 issue of Aviation and Aeronautical Engineering, will be completed in 24 issues. It will embody the fundamental aeronautical data necessary for aeroplane design and present the design of standard machines in complete simple and systematic form.

ables us to determine the part which these forces play in producing lift and drag. In Fig. 2, the results of a pressure force integration are shown from experiments on a R. A. F 6 wing, and compared with the usual force determinations

The result for the lift values coincides. Now, it is fairly clear that skin friction forces would not impart lift to a wing We can conclude that lift is solely due to the density or turbulence forces, and, further, that lift can be obtained from the integration of the components of the pressure forces perpendicular to the relative wind

The drag curves coincide at high angles, while between 0 degree and 8 degrees the drag derived from the pressure integration is less than that obtained from force experiments. The difference is due to the fact that the pressure results give an indication of skin friction forces.

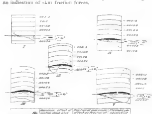

Fig. 4 Distribution of Pressure for Median Cross-Sections for Various Surfaces at 6 Degrees Angle i.

Effect of Variation of Speed and Scale on Lift and Drag Coefficients

These considerations enable us to deal more closely with the question of variation in coefficients with change of speed and scale, the product (lV).

Experiments at the N. P. L. show that lift coefficients are scarcely affected by such change. If, as has been shown, lift is due to pressure forces solely, there is no reason why the lift should be affected.

That portion of the drag due to density resistance and accounted for by the pressure integration would vary as AV^2 But the skin friction, not accounted for by the pressure experiments, varies as $bl^{.86}V^{1.86}$ Therefore, with increase in speed and scale, the drag would not vary as AV^2, but somewhat less rapidly, and K_x would not be a constant

It might be possible for any model wing to find the density component of the drag by allowing for skin friction, step this up to full size as AV^2 and then to compute the skin friction from the $bl^{.86}V^{1.86}$ formula. But we are not too sure of this formula, and the process would be very complicated

Some experiments at the N. P. L. provide, perhaps, the best guide, although they have been carried over too narrow a range. In Fig 3 are given values L/D for the R. A. F. 6 section, plotted at the same angle of incidence against log (lV); the logarithm being used purely for convenience in plotting. If the designer wishes to correct to the full sized machine, he must take the value lV which is given in connection with the section he employs and compare values of L/D at any angle of incidence with that corresponding to log $lV = 2.75$ $(lV = 560)$, a good value for a full sized machine The N. P. L. also gives corrections for lift, which are to be regarded with doubt, and corrections for drag coefficients. But it would seem safer to employ only the L/D corrections, and even these should be only used for the designer's personal benefit, or in comparing the merits of two sections, as in the last column of Fig 9 of Section 5 Designing without any corrections would be the most conservative method, and might ensure a pleasant surprise for full-size performance.

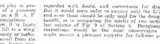

Fig. 5 Section Employed at the N. P. L. in Observing Pressure Distribution on an Entire Wing

Distribution of Pressure at Median Cross Section of Various Surfaces

With the ribs, stringers, fillers and good fabrics employed in modern wing construction, the stresses produced in the fabric are well within the limits of safety, as we shall see later. But it is important to remember that it is not the mean pressure over a wing which gives the maximum stress in the fabric it is the maximum pressure at one particular point. Also a small hole at one point of the fabric may cause it to carry the added effect of the suction at the upper surface and the positive pressure at the lower surface

Eiffel in his earlier experiments consistently investigated the pressure distribution over both surfaces and a number of his diagrams are shown in Fig 4, while the maximum effect of suction on upper surface and pressure on lower face is shown in table in Fig. 4, at the same angle of incidence of 6 degrees in each case The speed of the test was 32 feet per second.

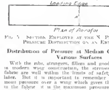

Fig. 6.

It is most important to notice how this maximum effect varies it is comparatively enormous in the bird's wing, with the thick leading edge, which is not unsatisfactory from an efficiency point of view, but which would require a greatly strengthened fabric, particularly as the maximum pressure occurs so very near the front edge In the Crescent shape the pressure is very uniformly distributed. Although these surfaces are not in common use, they serve as a qualitative criterion from this standpoint for more practical wings

An incidence of 6 degrees may be taken as normal flight, and at a speed of 60 miles per hour it is seen that pressures may vary from 13/4 to 8 82 pounds per square foot. This is, however, by no means the worst loading that can occur on a wing fabric. Under abnormal conditions such as flattening out after a steep dive, the maximum load per square foot may be many times greater. This question will be considered in detail in dealing with factors of safety

Distribution of Pressure Over the Entire Surface of a Wing: Lateral Flow, Its Bearing on Aspect Ratio

The most instructive experiments on the pressure distribution over the entire surface of an aeroplane are those due to Jones and Patterson at the N. P. L. and to Eiffel

At the N. P. L. a single wing section has been dealt with

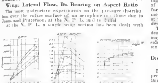

Fig 7. Contributory Effects of Various Elements of a Wing at Various Angles of Incidence Sections Located as in Fig 5

in this way, but there has been a close and useful analysis, which is a first step in the investigation of phenomena of lateral flow and of the underlying causes of the effects of varying aspect ratio.

A section resembling the R A. F. 6, but with somewhat greater camber, was employed Rectangular in plan it had a series of observation points as shown in Fig 5, on five sections parallel to the median section The actual methods were similar to those already described in considering pressure distribution over a median section, and the same remark applies to the resolution of components normal and perpendicular to the chord and their subsequent summation The centers of pressure for each section were obtained by taking moments by a process of elementary mechanics, a similar process is fully described in the Bulletin de l'Institut Aérotechnique Normal forces were again taken as a measure of the lift, and forces parallel to the chord as a measure of the drag, skin friction being neglected. The resolution of forces along and perpendicular to the chord, instead of along and perpendicular to the relative wind, involved the error already mentioned, unimportant, however, except at large angles.

In Fig. 6 are shown the curves of normal and parallel forces at the five sections for various angles of incidence. In Fig. 7, the contributory effects of each section of the wing is clearly illustrated by curves giving lift, L/D and center of pressure for each section The following observations can be made from this data:

(a) As each section, beginning with the median, is considered, the distribution on the upper surface from high suction forward and low suction aft alters progressively until when the tip is reached the highest suction occurs in the neighborhood of the trailing edge
(b) On the lower surface, the positive pressures found over the central portion of the wing fall off and eventually change sign so that near the tip almost the whole section is under suction
(c) At the same time, the areas of the curves of normal forces on upper and lower surface decrease at first to about , of their original value, but subsequently increase as the tip is reached
(d) Again as we move from the median section outward, the areas of diagrams proportional to parallel forces change from negative values (which oppose drag) to appreciable positive values, so that drag of the sections increases very rapidly in the neighborhood of the wing tips Thus maximum L/D at A is 24, at E it is only 5
(e) It is the variations in pressure distribution as we move out laterally which cause the center of pressure of the whole wing to move back.

This seems to demonstrate clearly that at the sides of the wing section there is a considerable amount of lateral flow, which prevents the establishment of a régime as efficient as at the center, where the air does not escape but follows the contour of the wing.

It is now also clear why increased aspect ratio is advantageous As aspect ratio is increased, the inefficient action of the exterior sections assumes less importance. Without further research it is, however, impossible to say whether increase in aspect ratio leaves the aerodynamical conditions at the median sections unaltered, or whether it improves conditions everywhere on the wing except on the lateral tips

These experiments may not be of immediate application in design, but may serve to give a better conception of what may be expected when a wing is varied in plan form. Besides the effects of varying ratio, these considerations would tend to explain the effects of raking.

Distribution of Pressure Over Entire Surface of Wing and Curves of Equi-Pressure

Eiffel employs an instructive method of curves of equi-pressure over the entire surface of the wing He has obtained such curves for flat plates and for cambered surfaces, but has unfortunately not carried his analysis very far, and gives us nothing beyond a graphical idea of the actual distribution of pressures In Fig 8 we find curves of equi-pressure and pressures at various sections for the Nieuport wing, which are somewhat more suggestive.

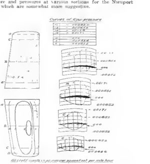

Fig 8 Distribution of Pressure on Nieuport Wing.

In the Nieuport wing, the sections, while preserving their general character, thin down as we move from the median section outward. This has the effect of maintaining nearly the same character of pressure distribution on all sections The outer sections have smaller values, it is true, but the maximum suction on them is still not far from the leading edge This from considerations of preceding paragraphs tends to minimize the aerodynamic inefficiency on the outer section A wing such as the Nieuport wing might, therefore, be very valuable, but further experiments would be necessary before this point could be definitely settled

Relative Importance and Interdependence of Two Surfaces

In Fig 9 are shown curves due to the National Physical Laboratory, which show the distribution of pressures along and normal to the chord on the upper and lower surfaces of two wing sections. The Sections are alike in their upper

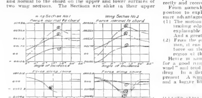

FIG. 9. DIAGRAMS ILLUSTRATING THE INTERDEPENDENCE AND RELATIVE IMPORTANCE OF TWO SURFACES OF A WING SECTION. COEFFICIENTS ARE IN FOOT POUNDS PER SQUARE FOOT PER MILE HOUR

surfaces, but one of them, Section 2, is hollowed out, while the other, Section 1, has a plane under surface.

As we have already stated the sum of two forces normal to the chord is scarcely distinguishable from the lift. And it can be readily seen from these curves that in both sections the upper surface contributes all the normal force at 2 degrees and nearly three-quarters of it at 12 degrees.

It can be deduced from this that the lower surface of a wing section provides not more than one-quarter of the total lift. We notice further that the forces for the upper surfaces in both sections are practically identical.

Section 1 has no components parallel to the chord; in section 2, as can be seen from the curves, the lower surface contributes very little of such components. Up to 7 degrees, the lower surface gives an upward force which helps to diminish drag; above this it has down a "downward" and detrimental effect. It can be seen here that the effect of the upper surface is similar in both sections.

From these considerations we can apparently conclude:

(a) That it is the upper surface of a wing which is by far the most important.
(b) That hollowing out a section has very little effect either on its lifting power or on its efficiency.

A somewhat similar conclusion was arrived at by Bendemann in examining a heavily cambered almost circular propeller section, the camber of the lower surface scarcely affected the value of the coefficients.

FIG. 10. DIAGRAM ILLUSTRATING THE PRINCIPLE OF THE DIPPING FRONT EDGE

Distribution of Pressure, the Principle of the Dipping Front Edge. Why a Wing Section Is Advantageous as Compared with a Flat Plate

We know from the pressure diagrams that for any wing such as that in Fig. 10, the pressure at A is negative while that at B is positive. This seems paradoxical, since A would appear to be facing the wind, while B is sheltered from it. Fage gives a very good explanation of this phenomenon commonly known as the "Principles of the Dipping Edge." Photographs, such as we have already given in Section 1, show that the wind is deflected upward as it approaches the leading edge of the wing. A, although it faces the general wind direction, is thus screened from it, and becomes a region of low pressure; while on B the relative wind impinges directly and receives a slight downward deflection.

From somewhat similar considerations, we are now in a position to explain roughly why a wing section is so much more advantageous than a flat plate.

(1) The suction on the upper surface of a wing toward the trailing edge is much greater than that for a flat plate, explainable by the principle of the dipping front edge. And a greater suction implies a greater lifting power.
(2) From the pressure distribution curves on the median section, it can be seen at once that the greater part of the force on the upper surface is due to the suction in the region at the leading edge.

Hence in summing up components parallel to the chord, for a good wing, the resultant force will tend to be "upwind" and tend to nullify the skin friction, reducing the total drag. In a flat plate no such advantageous action will be present. A wing will, therefore, give a greater lifting power and a bigger lift to drag ratio.

References for Section 7

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British Report 1911-1912. No. 60. Page 62.
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Luftschrauben Untersuchungen. F. Bendemann. Zeitschrift für Flugtechnik 1911-1912.
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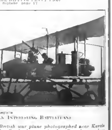


Photo by Paul Thompson

AN INTERESTING BATTLEPLANE

A two-seated British war plane photographed near Kavala. This is a French official photograph of a British aeroplane passed for transmission abroad by the French censor at Salonica.

Bombs are suspended beneath the fuselage. The construction of the heavy four wheel landing gear is interesting as affording a means for bomb-dropping. The observation window at the front of the fuselage, the machine gun mounting, pitot tube air speed indicator and the placing of the struts at the leading edges of the planes are also worth noticing.

Civilian Cooperation with Aviation Section, U. S. A.

Besides buying machines and training aviators, the Aviation Section of the Signal Corps, U. S. A., is cooperating with a number of civilian experts on official and unofficial committees. The work of these committees is outlined below.

SOCIETY OF AUTOMOBILE ENGINEERS' AERONAUTICAL ACTIVITIES

The activity of this engineering society is entirely outside of the Army organization, but in close cooperation therewith. In looking over its membership list it is seen that many of the members and associate members have business connections with manufacturing companies now making aeronautical material, either engines, planes, or accessories. These men, therefore circulate in connection with their business in the same circles as those engaged solely in aeronautical matters. From the list of the divisions of the Standards Committee of the Society of Automobile Engineers it will be noted that several of these committees are closely interested in aeronautical engineering matters.

When an engineering matter arises that requires committee action, in the way of standardization, it is submitted to one of the divisions of the Standards Committee. In this committee it receives careful study and consideration of the manufacturer, the consumer and neutral engineers. The findings of the division are handed to the whole Standards Committee for discussion and recommendation. If in the judgment of the Standards Committee, the action of the sub-committee has been a proper one, then the matter goes to the Society membership for ballot. In this way the engineering feature adopted becomes either recommended practice or a standard. The first of these conditions is probationary. If, during the period of probation, experience shows that the action has been a wise one, favorable action is usually taken to make it a standard.

One of the divisions of the Standards Committee has been making a study of motors suitable for motor vehicles. At the meeting of the Society in June a new division of the Standards Committee was created to consider motors suitable for aircraft. This committee has held two or three meetings, and is now actively at work in the consideration of propeller-hub recommended practice, spark plug standard, engine base width, piping and piping fittings, carburetor and carburetor fittings, electrical working and fittings, and a basis for engine weights as a function of horsepower.

These meetings have been attended by committee members, by invited guests interested in the subjects under discussion and by officers of the Army and Navy.

Through the activity and findings of this committee close cooperation is established between the engineering interests, the manufacturing interests and both branches of the United Service. The details under discussion meet the criticism of all interested in the matter from every angle. The objections raised by the manufacturer are met, as well as those made by engineers. The invaluable result attained is the establishment of a device, or part that fulfills the specifications of all concerned. A recommended practice, so adopted, usually endures.

The members of this division of the Society of Automobile Engineers are: Henry Souther, chairman, H. M. Crane, F. S Duesenberg, A. F. Milbrath, and L. M. Griffith.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

This committee is composed of a group of men which represent the many Departments of the United States Government. It was appointed by Congress and authorized to report to the President of the United States. Its activities look to the highest and most rapid development of the art of aviation. The personnel of this committee is as follows, with their titles and duties.

Brigadier General George P. Scriven, Chief Signal Officer, U.S.A., within whose bureau is the aviation section of the Army, under the immediate supervision of Lieutenant Colonel George O. Squier, Officer-in-Charge of Aviation, also a member of the committee.

The Navy is represented by Captain Mark L. Bristol, Commander of the Air Service, U.S.N., at present Commanding Officer of the *U. S. S. North Carolina*, the leading aeronautic ship in the Navy. Closely associated in the Navy with the development of aviation is the Construction Corps of the Navy, and Naval Constructor H. C. Richardson, U.S.N., represents this Department on the committee, and is also secretary of the committee.

The Bureau of Standards, which is the governmental department that deals with all scientific industrial problems, is represented on this committee by Dr. S. W. Stratton, Director of the Bureau.

The United States Treasury is represented by its Assistant Secretary, Hon. Byron R. Newton, who is in charge of the Coast Guard Service of the United States. This Department will probably use aircraft very extensively, and has already started to develop this art within its own organization.

The obvious connection between aviation and weather is made through Prof. Charles F. Marvin, Chief of the Weather Bureau who has already devoted special attention to the problem of the atmosphere in relation to aeronautics.

Dr. Charles D. Walcott, Secretary of the Smithsonian Institute, was closely connected with the earliest work done in the United States by Dr. Langley with a heavier-than-air flying machine, and the interest that Dr. Walcott took in this art persists, and to such an extent that he became, perhaps, the strongest promoter of the formation of this National Advisory Committee for Aeronautics. The Smithsonian Institution has for one of its duties the maintenance of up-to-date records relating to this art, among many others.

To this committee are also attached some of the brightest minds in mechanical and electrical subjects in the universities of this country, and these men are:

Prof. William F. Durand, occupying the chair of mechanical engineering in Leland Stanford Jr. University, Stanford University, Cal.; Prof. Joseph S. Ames, occupying the chair of physics, Johns Hopkins University, Baltimore, Md.; Prof. Michael I. Pupin, occupying the chair of electrical engineering in Columbia University, New York City; and Prof. John F. Hayford, occupying the chair of mechanical engineering in the Northwestern University, Evanston, Ill.

Scrutiny of the qualifications of the members of this committee clearly shows that it is most competent to deal with the many phases of aeronautics, whether of a scientific, practical or military character.

The scope of activities permitted by authority of Congress is a wide one, and this committee is fortunately not restricted by law or precedent in such a manner as to prevent complete and close cooperation with manufacturers or civilian engineers. This committee has prepared a nomenclature of the aeronautic art, is actively engaged in the consideration of new and novel engines for aircraft, new military devices for offense and defense, advanced photographic methods, new materials of construction, and, in fact, with every phase of airship usage. It is in the closest possible contact with European experience and with the activities in the United States.

The efforts of this committee will doubtless result in the discovery of much useful matter that the Army and Navy will put into practical service, and also of much information that will be made available to the manufacturer.

TECHNICAL AERO AND ADVISORY BOARD

This committee is within the Army organization and selected from officers and civilians in the Aviation Section of the Signal Corps, U. S. Army. All technical and engineering matters and decisions are submitted to this Board by the Officer in Charge of Aviation for consideration and recommendation. The Board is composed of officers who are themselves aviators, and some of whom have graduated from the aerodynamic course at the Massachusetts Institute of Technology. The civilian member of this committee specializes on engineering matters relating to aeronautical engines, accessories, and materials of construction. The personnel of this Board is as follows: Major Benj. D. Foulois, chairman, Captain V. E. Clark, Captain T. D. Milling, Captain H. W. Harms, Henry Souther, Naval Constructor J. C. Hunsaker, U.S.N., Consulting Member.

NATIONAL RESEARCH COUNCIL

This body of men is dealing with engineering and scientific subjects which relate not only to aviation, but to many other arts useful to the United States Government. Careful studies are being made of the natural resources of the United States, and, in fact, of the resources of the world, and the original source of all material.

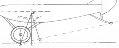
Relative Positions of Propeller Axis, Center of Gravity and Wheels

By Captain Byron Q. Jones

The following remarks apply to training machines such as land training machines of the tractor type used at the San Diego Signal Corps Aviation School under fairly good landing conditions These machines have also been used in cross-country work in the neighborhood of San Diego, Calif., and the remarks might also be considered to apply to machines used for average flying conditions.

PROPELLER AXIS

It has been found that if the distance between the tip of propeller and the ground, with the propeller axis horizontal is not less than 10 inches, no injury is apt to result to the propeller



Machines with that amount of clearance have been used at this school for a considerable time No propeller trouble due to this apparently small clearance has been experienced

POSITION OF THE CENTER OF GRAVITY WITH RESPECT TO THE WHEELS

If, in the accompanying sketch, the point B is the intersection of the vertical line through the center of gravity of the machine with the propeller axis, with the propeller axis in the horizontal position, the point A, the point of tangency of the wheel, point C the intersection of the vertical line through the center of gravity with line through point A, and the point of tangency of the tail skid when resting on the ground, which we will call E, and point D the intersection of the line AE with the line through B perpendicular to AE, then the angle ABC should be as nearly as possible 13 degrees 10 minutes, and CBD as nearly as possible 13 degrees.

The above holds true for a two-wheel landing gear If front wheels or skids are provided, then the angle ABC may be less It has been found, however, that if the wheels are in the above position with respect to the center of gravity considered at the point B, there will be no tendency of the machine to go over on its nose, even in very poor landings

On the other hand, considerable trouble has been experienced at this school due to front wheels or skids This for the reason that a good many landings by pupils are made such that the front wheel or skid comes in contact with the ground while the machine is moving "crab-wise" This causes a failure of the front wheel, and, due to the drag or resistance of the front wheel, has caused considerable injury to the machine.

Our recent experience with the two-wheel type points clearly to its advantage over any chassis with front wheel or skids The limiting angle of 10 degrees to the angle CBD has been determined from experience in landing machines on the ground, i.e., taxying The greater this angle is, the more difficult it is to taxy a machine, especially in the wind It can be easily seen that if a machine is running along the ground, and due to side wind or some other cause, its tail swings a little, the wheels are necessarily turned a little off from the course. The momentum of the machine tends to keep it in a straight course As soon as the wheels begin to move a little sideways, a turning moment is introduced, due to their resistance, i.e., the friction of the tires on the ground Then the greater the distance AD, the greater will be the turning moment The greater the turning moment, the greater tendency will the machine have to 'spin,' or turn into the wind Unless this is offset by an opposite turning moment brought into play by the tail skid, the machine will continue spinning, finally becoming uncontrollable This has resulted in a number of accidents to machines causing the failure of a wheel, and the machine going up onto its nose.

It can thus be seen that a very definite compromise must be made between height of propeller axis, location of center of gravity, and the position of the wheels. Machines with the angles as indicated above have given the most satisfactory results at this school, both in landing and in taxying.

STAGGER OF AXLE GUIDE

So far there seems to be nothing definite regarding the angle which the guide of the axle in the landing gear should be set at. In the Curtiss Model JN 4 type, with the elastic cord shock absorber, this guide is set such that when the propeller axis is horizontal, the guide is staggered 15 degrees to the rear, and 25 degrees to the rear with the tail skid resting on the ground. This guide is provided with a bronze bushing on the rear face to take up the wear It has been found that, unless the elastic cord is put on just so, the bronze bushing undergoes no wear at all, the front face of the guide taking all of it. The result has been that the aluminum casting furnishing a saddle over the axle for mounting the elastic cord, has worn through, and in one case the axle has worn in as much as an eighth of an inch Also due to repeated shocks, the front guide has failed by buckling

As an experiment on stagger of axle guide, a plate was made up and mounted on the JN 4 chassis such that the guide had a stagger of 10 degrees *forward* with the propeller axis horizontal, or a zero stagger with the tail skid resting on the ground. So far no wear has been observed on either the axle or the saddle The machine seems to land and taxy just as well, and there is no apparent tendency of the machine to nose over in a bad landing This would seem to indicate that the stagger of the guide has but little if any influence on the landing qualities of the machine, and that the whole consideration to be given to the angle of stagger depends entirely upon wear Inasmuch as most of the wear is caused by taxying on the ground, it is reasonable to assume that that angle, i e., zero degrees with the tail skid down, which brings about the least wear is the one most suitable

A further report will be made on this angle of stagger when the guide, mentioned above, i e , zero degrees stagger with the tail skid down has been given a more thorough practical test.

* Captain Byron Q. Jones rules for the position of center of gravity are very valuable but it is possible that they may not be right in application to heavier types of machines The question of employing a two-wheeled chassis is highly controversial, other known types of chassis being employed most successfully —Ed.

Frankford Arsenal Aerial Torpedo

One of the men at the Frankford Arsenal in Philadelphia, is perfecting a new aerial torpedo It has been tested by Army fliers at the Mineola aerodrome, and may be adopted

With the use of an electric time device, the aviator may control the time of explosion so that it will occur at a fixed distance from the ground, thereby scattering its charge of shrapnel. The tests have been so successful that a favorable report will be made to the War Department, recommending the adoption of the bomb

The effectiveness of the new bomb is said to be greater than that of any such missile ever tried here or known in the European war zone

The inventor has offered the exclusive use of his invention to the United States Government The bomb is six feet long, is shaped like a torpedo, and carries, in addition to its poisonous gas charge a heavy explosive charge.

Official Specifications for Army Hydroaeroplanes

This specification describes the design, construction, equipment, and requirements of a military hydroaeroplane adapted to coast defense reconnaissance

GENERAL REQUIREMENTS

The following characteristics shall be proven to the satisfaction of the inspectors appointed by the Government for the purpose

1. This aeroplane shall be a two-place biplane or triplane, with power plant consisting of two motors and two propellers

2. It shall be designed for carrying a useful load, comprising the following

(a) Pilot and one other 330 pounds

(b) Supply of gasoline, oil, and water necessary for a flight of five hours duration, with motors turning continuously the number of revolutions per minute required for their rated horsepower

(c) Instruments and equipment 150 pounds [NOTE—For calculations for longitudinal balance and statical stability it will be assumed that the moments of these masses forward and aft of the center of gravity are equal]

UNLESS OTHERWISE SPECIFIED, THE USEFUL LOAD CARRIED ON ALL PERFORMANCE AND MANEUVERING TESTS SHALL BE EQUIVALENT TO THE ABOVE

3 The rated horsepower of the complete power plant consisting of two motors shall be between 170 and 300 Looking from the rear the right-hand propeller shall turn counter-clockwise, and the left-hand propeller shall turn clockwise

4 The horizontal low speed shall not exceed 45 miles per hour

5. The aeroplane shall be capable of a sustained flight of 3½ hours, carrying pilot and one other

6. The aeroplane shall be capable of arising from the water in flight while running before a wind of 5 to 7 miles per hour with load as

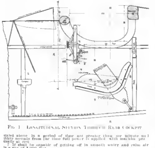


FIG. 1 LONGITUDINAL SECTION THROUGH REAR COCKPIT

[illegible]

of being anchored for not less than one-half hour in open water in wind of velocity not less than 25 miles an hour without material damage A sea anchor shall be used for this purpose The general arrangements including design of floats, shall be such that the tail planes are held clear of the water when the aeroplane drifts astern in a wind velocity of not less than 25 miles an hour The arrangement shall be such that when taxiing in a moderate sea the propellers are not unduly subjected to the action of the spray The aeroplane shall be supplied with suitable bow chocks and cleats or other suitable means for towing or mooring.

Controls—Controls shall be of the standard Deperdussin type, installed in the rear cockpit only The action of the control shall be positive, reliable, and such as to give the proper power ratio. The lateral control shape shall be double acting

Stabilizer—Aeroplanes designed for and provided with automatic controlling devices of approved type will be favorably considered. The use of a lateral stabilizer is especially encouraged. Positive, quick, convenient, and reliable means shall be provided to permit the pilot to cut out any automatic stabilizer

Protection—All material, parts, instruments, and accessories of aeroplane and power plant which will suffer either in material or in functioning from dampness and exposure to salt water must be satisfactorily protected therefrom Any provision possible should be made that will render any vital portion of the aeroplane or power plant structure relatively invulnerable to the fire of small arms or shrapnel without material sacrifice in the design strength or weight.

Power plant—All motors furnished under this contract shall show proper functioning at all heights from sea level to 7,000 feet The vibration initiated by the power plant at any normal speed of revolution shall not be excessive This will especially apply at the normal speed of motor operation

Field of vision—The field of vision of pilot and observer will be indicated on the prints submitted with the bid

DESIGN OF HYDROAEROPLANE

The general arrangement of this aeroplane shall be as follows The pilot and observer shall be in a central body The arrangement of this body shall be such as to permit the man forward to conveniently operate a machine gun on the front through an arc in a horizontal plane of at least 150° and through a vertical arc of at least 270° with the gun at an angle of about 15° to the X axis of the aeroplane, muzzle forward of the plane of rotation of the propellers. The arrangement shall permit the rear man to conveniently operate a machine gun through an arc in a horizontal plane of at least 150° to the rear and through a vertical arc of at least 180° with the gun at an angle of about 110° to the X axis of the aeroplane and muzzle in rear of the plane of rotation of the propellers.

Gasoline tanks—The tanks for the main supply of gasoline shall be in this central body and so located with respect to the center of gravity of the aeroplane that the longitudinal aerodynamical balance of the aeroplane will not be appreciably disturbed as the gasoline supply is diminished or increased throughout the full capacity range.

[illegible]

All details of construction shall be satisfactory and in accordance with the best practice. In the general design of wing girder and motor support satisfactory provision, preferably by struts completely independent of motor supports, shall be made to prevent the wings collapse in case an air bolt motors are suddenly thrown bodily out of balance due to breakage of propeller or other accident. Provision shall be made in the wing girder structure, between the motor supports and the central body structure to reduce to a minimum vibration and its effects resulting therefrom. If the design is such that a central body projects forward of the plane of rotation of the propellers, the clearance of propeller tips from the sides of this central body shall be between 8 and 12 inches. No part of the gasoline supply tanks which are contained in the central body shall lie in the plane of rotation of the propellers nor within a space of inches forward of this plane. The number of important wire and other connections which extend across the plane of rotation of the propellers should be reduced to a minimum. It is considered very desirable to incorporate

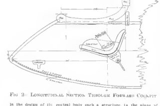


FIG. 2. LONGITUDINAL SECTION THROUGH FORWARD COCKPIT

in the design of the central body such a structure, in the plane of rotation of the propellers and for a distance of 6 inches forward of this plane of rotation as will prevent a broken propeller blade or hub from entering the central body. Some such system as that used in cage masts of battleships is suggested, a number of spruce compression members preferably being used instead of wires. The structure of the forward part of the central body shall be of sufficient strength to withstand a reasonably heavy load, due to nosing over on a landing without dangerous buckling.

Seats.—The seats shall be arranged in tandem, the pilot's seat being directly in rear of that for the observer. The seats shall be so arranged as to afford a clear view with vertical and horizontal adjustment.

Cockpits.—The arrangement of cockpits and dimensions thereof shall be as nearly as practicable to that shown in Figs. 1 and 2. In addition, if practicable, the pilot shall be provided with quick release arm rests. Suitable means of hand grips shall be provided in which pockets are made, should be finished in longerons and vertical posts in such a way as to prevent a flying man, for inspection of structural wiring and fittings.

Safety belts shall be provided for both seats, as indicated in Fig. 3 and securely fastened at points as indicated. The design and construction of these belts shall be such that they will safely support at any point a load of 2000 pounds, applied as in practice. Rubber shock absorbers incorporated in the safety belt system are considered to be very desirable. The quick release device employed shall be as indicated in the attached print and shall unlatch and quickly function. A space extending at least 6 inches back of the seat of the observer and across the entire transverse section of the central body shall be left open and unoccupied. Space in the pilot's cockpit etc. may be installed therein. In the center line of the floor of the observer's cockpit shall be a circular hole 8 inches in diameter, the rear of the hole 5 inches forward of the forward edge of his seat. A suitable transparent cover for this hole, readily displaced from the inside, shall be provided. A readily detachable cover or canvas shall be provided along the top of the fuselage over the front. Such cover or canvas shall be positively secured in place. Lateral and longitudinal provision shall be made to permit walking without damaging the wing covering on the lower wing on both sides of the central body and on both sides of each motor. Wing surface covering under and in rear of carburetors shall be protected by sheet copper and aluminum sheet or other suitable means.

Knockdown.—The provisions for rapid assembly, disassembly and for packing in crates of convenient size, weight and shape for transportation in standard size freight cars must be satisfactory. The number of bolts, fittings, and other parts which it is necessary to remove or disturb when disassembling shall be as few in number and as simple as is consistent with other requirements.

Cables which are members of the wing structure and normally under tension shall be duplicate and independent between fittings.

The radius of curvature at pulleys where control leads are changed in direction shall be not less than 12 wire diameters. Pulleys shall be located in place and guides shall be provided to prevent the cables from leaving the pulleys.

Floats.—The aeroplane shall be provided with two main floats and such others as may be necessary. The distance between center lines of these floats shall be between 12 and 15 feet. The design of the main floats shall comply with the following.

The ratio of length to beam shall be such as to give sufficient metacentric height for longitudinal stiffness and at the same time give sufficient planing area.

The bottom to have one step located near the plane containing the Y and Z axes of the aeroplane. The bottom, forward of this step, shall be of the V or concave V type. Each main float shall have displacement in sea water not less than 85 per cent of the total weight of the entire aeroplane with load. Each main float shall have not less than four watertight compartments. Each compartment shall be provided with convenient means for pumping. For inspection and cleaning a deck manhole with cover readily and quickly detachable must be provided. The clearance of the propeller tips above the top of the floats shall be not less than 6 inches. It shall be considered desirable to have water rudders of sufficient area to permit accurate steering on the water when the propeller speed is low. The floats shall be readily detachable. Particular care should be taken to insure continuity of strength in the hull, particularly between the point of support of the struts and the step. Also that the points of attachment of the struts to the hulls are thoroughly reinforced locally in the interior of the floats. Floats constructed from suitable metal are considered desirable. The width of strips on the outside skin of floats, which may be made of wood, and the initial gap between strips shall be such as to render the structure water-tight and yet prevent buckling of the strips after being swollen by the action of the water. Hard wood runners shall be provided to protect the float while on the beach. This construction shall permit renewal.

Sea anchor.—A sea anchor shall be provided. The design and material shall be such that the action of the sea anchor shall be efficient under various conditions; that it be durable and light, and occupy when stowed as small a space as possible. Space shall be allowed in the central body in rear of observer's seat for stowing the sea anchor. While in use it shall be attached by a suitable bridle and quick-detachable fastening hooks to the two points along the bottom longerons of the central body, at the junction of the two vertical posts in rear of the front seat. The structure of the central body shall be such as to withstand the stresses imposed by the sea anchor.

Standard parts shall be used wherever practicable. In general the S. A. E. standards will be accepted. These standards for screw threads shall be used wherever possible. U. S. standard threads will be acceptable where threaded into cast iron, cast aluminum or copper alloys.

Fittings, sheet or forged, must be free from sharp corners and supplied with generous fillets. This applies to turnbuckles. All nuts and pins shall be fitted with one or more positive and durable safety devices. In general, where it must be expected that a structural fitting will be disassembled a number of times during the life of the aeroplane, castellated nuts with split pins, in accordance with S. A. E. standards, shall be used. Wherever this is not the case pins or bolts shall be riveted in a workmanlike manner.

MATERIALS

With the exception of floats, surface covering, webs of wing ribs, and the rawhide, the structure of the aeroplane shall as far as is practicable consist of spruce, steel, and copper alloys. All wood shall be straight grained, well seasoned, of uniform weight, and free of knots, pitch pockets, checks, or cracks. All spruce shall be of the very highest

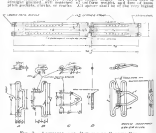


FIG. 3. ASSEMBLY AND DETAILS OF SAFETY BELT

grade of selected straight even grained clear spruce. It shall be air seasoned, preferably for at least two years. Kiln dried wood is not acceptable. All wooden members especially faying surfaces, end grain butts, scarfs, and joints shall be protected against access of moisture, before final assembly by best grade of varnish, or by impregnating with paraffin.

When the floats are wholly or partially constructed of wood, the internal wooden structural members shall be impregnated with paraffin or mineral oil. No laminated wooden parts shall be used except where absolutely necessary. No laminated wing rib webs shall be used. Spliced joints will be permitted only where absolutely necessary. The scarfs of spliced joints shall be liberal and the joint shall be made by using dowels and copper rivets, and the entire scarf bound with Finlayson's 40-pound waxed shoe thread. Each ten turns shall be locked. Glue used in the various points of structure of aeroplane and floats shall be the highest grade and best for the purpose.

All wood members of interior wing and tail surfaces shall be treated as follows to protect against the action of salt water:

Three coats of best spar varnish—butts assembled wet with varnish. Alternative: Impregnation with paraffin.

All wooden surfaces normally exposed to the direct rays of the sun, including decks of floats, shall be treated as follows:

Two coats white lead followed by one coat white elastic enamel, mixed with a proper quantity of lead chromate. The enamel shall be of the best grade for this purpose.

All tacks used throughout the structure shall be of copper or brass.

Metal parts.—It is considered highly desirable to have all bolts, pins, plate fittings and turnbuckle ends made of chrome vanadium steel, S. A. E. specification 6130, heat treated to produce the physical characteristics desired. All parts and fittings that must be bent shall be heat treated after all bending operations are completed and by such a sequence of treatment as will produce the desired grain and toughness and relieve all stresses due to bending. This includes sheet and forged steel fittings, turnbuckle ends, bolts and pins. In general, the materials and treatments specified in S. A. E. data sheets shall be followed. All steel parts and fittings of the aeroplane construction submitted to

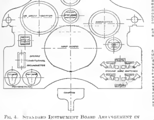


FIG. 4. STANDARD INSTRUMENT BOARD ARRANGEMENT IN PILOT'S COCKPIT.

stress or vibration shall be heat treated in such a manner as to produce the highest possible refinement of grain and give the greatest possible resistance to alternating and vibratory stresses. The character of the treatment shall produce the best combination of strength and toughness possible with the grade of steel used. The grade of steel used shall be that best suited for the particular part of the structure and the duty it is to perform.

Wiring.—All wire tension members of the aeroplane structure which are enclosed and not readily accessible for inspection and adjustment of turnbuckles shall be of single-strand high tensile hard wire. (See specifications for wire.) For all tension members which are readily accessible for inspection and adjustment nonflexible stranded steel cable shall be used. For all control leads, Roebling's flexible phosphor bronze cable 7/32 inch diameter composed of 7 strands, each strand 19 wires, having tensile strength of not less than 2,500 pounds shall be used. For turnbuckle safety wiring No. 20 gauge semihard copper wire shall be used. The method of making terminals for all wire and cable sections shall be approved by the inspecting department.

All cable shall be well stretched before making up and fitting. A load equal to 20 to 30 per cent of the breaking load should be applied for a period of two to three hours. Control sections shall be subjected to a tensile load of 500 pounds, continuously applied for a period of eight hours.

Hard single-strand wire shall be of sufficient tensile strength to comply with the requirements of factor of safety at all points and shall in addition be such as to undergo without material injury a bending test as follows:

The wire to be bent on a right angle turn over a radius equal to the diameter of the wire, back and forth five times each way.

Turnbuckles.—Not more than four sizes shall be used in the entire aeroplane structure.

Interchangeability is required.

The minimum strength under tension shall be as follows:

Turnbuckles, size No. 1, 8,000 pounds.
Turnbuckles, size No. 2, 4,600 pounds.
Turnbuckles, size No. 3, 2,700 pounds.
Turnbuckles, size No. 4, 1,100 pounds.

All parts of control-wire pulleys shall be of copper alloy.

All parts of hinges of all control surfaces shall be of copper alloy, satisfactory to the inspecting department. They shall be attached to the main spars on both sides by a sufficient number of through bolts with washers liberal in bearing area and thickness.

Control columns for elevators and parts in the vicinity of compasses shall be as much as is possible, of non-magnetic material.

Protection.—All steel plate and forged fittings shall be protected against the action of salt water by baking enamel, the best standard three-coat process being used.

All steel bolts, nuts, pins, and rotter pins shall be protected by heavy nickel plating over copper.

All covered wiring and turnbuckles shall be protected by at least two coats of Flexible Compound (Flexible Compound Co., Philadelphia, Pa.)

Steel tubing shall be thoroughly cleaned, slushed with mineral oil inside, and plugged at both ends with wood impregnated with paraffin or mineral oil.

Linen fabric.—The fabric shall be made from the finest flax fiber well woven and unbleached.

The yarns should be wet spun with a moderate amount of twist and uniform in yarn number, and strength.

The cloth shall be free from defects due to faulty preparations, spinning, weaving, or finishing such as snarls, knots, and loose ends.

The cloth shall be boiled to remove all noncellulose matter and no filling agent of any description shall be used when finishing. The cloth must not be calendered. The width shall be not less than 36 inches. The weight shall be between 3.75 and 4.4 ounces per square yard. Warp yarns per inch 84. Filling yarns per inch, 100 with a maximum variation of five yarns. Tensile strength minimum, warp, 75 pounds per inch of width; filling, 85 pounds per inch of width.

Between linen and the heads of outside tacks shall be heavy linen tape with both edges frayed. The width of solid tape shall be between ¾ and 1½ inches and the width of frayed edges about ¼ inch. All linen surfaces after assembly on the frames will be treated with at least three coats of solution of cellulose, approved by the inspection department, carefully applied. Over the cellulose coating shall be applied at least two coats of a varnish approved by the inspection department. It is considered desirable to coat the top surface with one coat of white elastic enamel of the best grade for the purpose, in which a small quantity of lead chromate is mixed. It is required that the entire completed covering be reasonably waterproof, reasonably noninflammable and such as to retain its elasticity and original form for a satisfactory period of time under various weather and salt water conditions. The color shall be as nearly white as possible. Holes about 3/16 inch diameter with rustproof eyelets shall be placed in surfaces of all wing and auxiliary surface structures. These holes shall be located between all ribs, near the trailing edge, and near inner rib. If no wing tip floats be provided, handholes shall be placed at each tip of the lower wing, just in rear of the front spar.

Seat pads.—Shall be quickly detachable in order that they may be used as life preservers. They will be filled with kapok or other similar material and covered with real leather to protect it against the action of salt water.

WORKMANSHIP.

All metal fittings shall be true to form and free from injurious surface defects or injuries due to imperfect workmanship. Extreme care shall be taken not to cut or pierce beams or struts in such a manner that the important fibers will be ruptured at vital points. Where plate fittings are in contact with wooden members, sharp edges next to the wood shall be removed. In making up and connecting steel fittings, welding will be used wherever possible. If impracticable to weld, and in such cases only, brazing will be used; proper heat treatment to be employed to restore desired strength and toughness of the metal after such welding or brazing. Extreme care should be exercised to avoid nicking or kinking any wire, cable, or fitting. Where pins are riveted at fittings, the rivet head shall draw the fittings as close as possible without crushing, and each head shall be liberal in diameter and height. In the construction of main planes and auxiliary surfaces the flanges of ribs shall be secured to the webs by glue, copper or brass tacks of proper size and properly spaced, and in addition by loops of Finlayson's 40-pound waxed shoe thread passed completely around the out side of the flanges, drawn tight and each loop locked. The space between loops shall be between 3 and 5 inches.

ACCESSORIES AND INSTRUMENTS

The following instruments and accessories shall be provided. Their design, location and arrangement shall be such that they function with satisfactory precision and reliability under various flying and service conditions.

The arrangement of instruments in the pilot's cockpit shall be substantially the same as that indicated in Fig. 4.

1. *One aneroid barometer*, graduated in feet, registering from sea level to 12,000 feet, to be installed in rear cockpit; to be neatly marked with radium compound No. 6, manufactured by Radium Chemical Co., Pittsburgh, Pa., in such a manner that it can be plainly read at night. The barometer supplied by the Taylor Instrument Co., Rochester, N. Y., or one equally as satisfactory, shall be used.

2. *One clock.*—To be located in rear cockpit. The design and construction of this clock shall be such that it will function properly in a system vibrating as does an aeroplane under various conditions. The clock manufactured by the Chelsea Clock Co., Chelsea, Mass., or one as satisfactory for the purpose shall be used. Dial of clock to be marked with radium compound, as specified above.

3. *Two compasses.*—One in each cockpit. The observer's compass and, if practicable, also the pilot's compass, shall be attached to and synchronized with a ground drift indicator also to be provided. The suspension arrangement of compass in body shall be very elastic and properly damped. The ground drift indicator shall be in a convenient location in the observer's cockpit. Both compasses shall be manufactured by the Sperry Gyroscope Co., of Brooklyn, N. Y., and marked with radium compound as specified above.

4. *A gasoline-supply gauge* will indicate accurately the supply of gasoline in the gravity service tank in all normal flying attitudes of the aeroplane and shall be visible from the pilot's seat. It will also be considered desirable to have an accurate gauge in the main tank, which will indicate the approaching exhaustion of the supply of gasoline in this tank. This indicator should register when 75 per cent of the capacity of the main tank is exhausted and then indicate continuously the amount of the remaining supply.

able, to be marked with radium compound No. 6 as specified above.

5. *Air speed indicator.*—One in pilot's cockpit. Indicator, if practicable, to be marked with radium compound No. 6 as specified above.

6. *Angle of incidence indicator.*—One to be located in the pilot's cockpit. The indicator as manufactured by the Sperry Gyroscope Co. will be used.

7. *Inclinometer.*—One indicator for angle of inclination of longitudinal axis. Located in the pilot's cockpit to be placed on the instrument board in the immediate vicinity of the tachometers. If practicable, to be marked with radium compound No. 6 as specified above. The instrument manufactured by the Sperry Gyroscope Co., Brooklyn, N. Y., shall be furnished.

8. *One instrument* for indicating proper bank, to be located in the pilot's cockpit, if practicable to be marked with radium compound No. 6 as specified above. The instrument manufactured by the Sperry Gyroscope Co., Brooklyn, N. Y., shall be furnished.

9. *Map board.*—One rotating map board, to be located in the pilot's cockpit.

10. *Map desk.*—One folding map desk located in the front cockpit, in a convenient location and manner, shall be furnished.

11. *Speaking tube.*—One speaking tube for communication between pilot and observer 1 or 1¼ inches inside diameter, flexible fabric covered with rubber, light in weight, with soft rubber bells with a maximum diameter of 2½ inches at each end. The belled ends to be hung at convenient points in the cockpit and arranged so that they may be readily brought to the men's heads while they are sitting upright.

12. *Flashlight.*—A flashlight or other suitable signal by which pilot may call the attention of the observer to the speaking tube shall be installed.

13. *Pyrene fire extinguishers.*—Two. One shall be securely mounted at the side of and slightly to the rear of each seat, in such a way as to render it convenient for handling.

14. *Water breaker.*—One at a point immediately in the rear of the pilot's seat as low as possible in the fuselage and such as to be readily accessible to him. It shall be light, noncorrodible, leakproof, preferably of copper or copper alloy, capacity of two gallons.

15. *Tool kit.*—Tool kit in a convenient case immediately in rear of pilot's seat in such a position as to be conveniently accessible to the pilot without removing the rear body cover. It shall contain the following tools and parts. These tools shall be of the very best grade obtainable. 4 spark plugs, 1 one-pound roll of friction tape, 1 roll of 20 Ga. hard-copper wire, 1 spark plug socket wrench, 1 one-pound hatchet with hammer end, 1 double open-end wrench ¼ and 5/16 A. L. A. M., 1 double open end wrench ⅜ and 7/16 A. L. A. M., 1 mill file 10-inch, 1 Crescent or Sterling 6-inch wrench, 1 Crescent or Sterling 10-inch wrench, 1 pair 6-inch combination pliers, 1 pair 8-inch Klein wire cutters, 1 screw driver 7 inch, 1 cold chisel ½ inch, 1 special tool for tightening turnbuckles, 1 spool linen fabric thread, with needles, 1 special magneto wrench, 1 magneto point file, 1 box containing miscellaneous assortment nuts, bolts, cotters, clevis pins, etc., as used in aeroplane structure. The weight of the tool kit shall not exceed 11 pounds. In this same general locality shall be suspended a light funnel which can be used for oil, gasoline or water and a collapsible 1 gallon bucket.

POWER PLANT

A. DESIGN

The design of the power plant shall be such as will be suitable for installation in a military hydroaeroplane using twin engines. Each engine shall be capable of developing between 85 and 110 horsepower continuous operation. Experimental or unproven motors will not be acceptable under this specification. The type may be 6-cylinder vertical, 12-cylinder V or 8-cylinder V. All engines shall be water cooled. The desired speed of revolution of propeller for rated horsepower is between eleven and thirteen hundred revolutions per minute.

The carburetion and lubrication system shall be such as to permit running the motor at a speed of revolution 20 per cent of that for the rated horsepower. The engine should run smoothly and reliably for at least 15 minutes while thus throttled and pick up quickly and reliably to full power.

All moving and reciprocating parts shall be balanced in every way consistent with the design of the engine and where possible statically and dynamically.

Interchangeability of parts is essential. The consumption of gasoline shall not exceed 0.65 pounds per horsepower per hour. The consumption of oil shall not exceed 0.06 pounds per horsepower per hour. Engines shall not vibrate excessively in flight at any speed of revolution and particularly at that speed which develops the rated horsepower and at which the motor will be normally operated. Provision to materially silence the exhaust of the engine is desired. Such provision however is not considered of sufficient importance to warrant serious addition of weight or loss of power. All gears shall be incased and made oil tight. The crank case shall be oil tight. The engines throughout shall be oil tight to such an extent as not to throw oil over the aeroplane or its occupants.

Propeller shaft.—The propeller shaft shall conform to drawings and master gauges which will be furnished by this office. Standard parts shall be used wherever practicable. In general, the S. A. E. standards will be accepted. S. A. E. standard fine screw threads shall be used wherever possible. U. S. standard threads will be acceptable for threads in cast iron, cast aluminum or copper alloys. Illustrations of the latter standard are pipe fittings and connections. S. A. E. screw standards, including bolts, nuts, cotter pins, lock washers, seamless steel tubing, carburetor flanges, ball bearings, roller bearings, and other items shown on the index sheet of the S. A. E. data book, Volume I.

An exception to the use of the S. A. E. standards will be found in the spark plug below the collar, which shall be the standard "18 millimeter metric" thread. The length of the plug below the collar shall be such that the plug shall not be flush, except nor recessed more than ⅛ inch with walls of cylinder. The best possible means to make the timing of the engine correctional shall be provided. Magnetos and carburetors shall be readily accessible for repair, removal or inspection. All bolts, nuts, and screws shall have a positive and durable locking device.

B. INSTALLATION

The ease and convenience of removing and installing engines in the aeroplane with the minimum disturbance of leads, controls, and structure shall be satisfactory to the inspection department. If housing around the engines be provided, it shall be readily detachable, and in addition have means for convenient access to all parts of the engines that may require adjustment, removal, or inspection. Wiring and electrical fittings shall be insulated, armored, and fastened in such a manner as to resist vibration, chafing, oil or water soaking, and shall be up to the standards for motor-car wiring prescribed by the S. A. E.

All electric wiring between central body of the aeroplane and the engines shall pass through or along the upper wing panels. Every precaution shall be taken to prevent collection of gasoline within the engine or within any of the surrounding structure. Proper drainage devices or holes shall be installed.

C. MATERIAL

The materials used shall be best suited for the design, workmanship and function of each part of the engines. The high duty requirements of aviation service must be considered. Material throughout and the methods of protecting such material shall be such as to reduce to a minimum the deterioration due to wear, vibration, and the action of salt water and moist air.

D. WORKMANSHIP

The workmanship shall be of the very highest grade demanded by aeroplane usage. It shall be suited to the design and materials used. The vital operating parts shall be constructed with close and uniform tolerances necessary for best performance in service and such as to permit interchangeability. All parts shall possess such a degree of finish as will insure proper balance, minimum weight, and all surfaces shall be free from objectionable roughness and foreign material (such as scale or sand) being protected from the weather as far as possible by suitable plating, enamel or paint, carefully applied over thoroughly cleaned surfaces. Liberal fillets shall be left where necessary. The workmanship on propeller shaft taper shall be accurate to such a degree as to permit all hubs to be interchangeable.

GASOLINE SUPPLY

[illegible]

... permit convenient operation by the pilot in his seat. It shall be provided with a suitable air pressure gauge visible to the pilot. The connections with the compartments of the main tank shall be at a point as high as practicable to prevent the pump becoming flooded with gasoline. An arrangement by which pressure may be maintained by a hand air pressure pump on tight compartments of the main tank should one or two compartments leak is highly desirable.

Gravity service tank.—The gravity service tank shall be of sturdy construction, securely supported in place and provided with the proper number of swash baffle plates. It is considered desirable to protect this tank with light V shaped armor on the under side. No automatic float valve shall be provided to prevent over filling of this tank. A suitable overflow pipe out of the top center of the gravity service tank shall be provided. A suitable gauge visible to the pilot in his seat shall be in the gravity service tank. This gauge shall be connected at such a point that it will register accurately through the range of normal flight attitudes. The gravity service tank shall be of good stream line form. From the gravity service tank the gasoline shall be led to a small header at each engine by leads within the lower wing panels. Between gravity service tank and each header shall be two independent and as far as practicable isolated leads. Each of these four leads shall connect with the lower part of the service gravity tank at such a point that the supply will not be interrupted at any normal flight attitude. At the connection of lead to gravity service tank shall be a suitable wire gauze strainer mesh to the inch. Provision shall be made to prevent the possibility of pockets in the gasoline leads from the gravity service tank. Provision shall be made for permitting the pilot, while in his seat, to cut off the gasoline supply, through all leads, from the gravity service tank to the carburetor headers.

Headers.—A small cylindrical or stream-line tank or header shall be installed in the immediate vicinity of each carburetor. The gasoline shall pass through this header after coming from the gravity service tank. The capacity shall be sufficient for one minute's running at rated horsepower. The central portion of this header shall be on a level with the jets of the carburetor. The axis of the cylinder shall be vertical. The cylinder shall be of sufficient length to give satisfactory head, either when the aeroplane is in normal attitudes or when upside down. Provision shall be made to prevent gasoline from backing up into the service lead instead of coming into the carburetor when the motor is upside down. Suitable gasoline cut-off shall be installed near this header in such a position as to be convenient for operation to a man standing on the ground or on the wing.

Fuel leads.—The tubing for fuel leads at every point shall be of the highest grade material best suited for the purpose. It shall be approved by the inspection department. Flexible tubing shall be ... inch copper tubing No. 2 as manufactured by the Pennsylvania Flexible Metallic Tubing Co., Broad and Race Streets, Philadelphia. Nonflexible leads shall be piping as approved by the inspection department. Tubing shall in all cases be of diameter sufficient to give free and continuous flow under severe vibratory conditions. In the absence of other instructions the bore shall be 5/16 inch. All tubing shall be securely fastened in such a way as to resist wear, vibration and chafing. The number of joints and fittings shall be reduced to a minimum. Unions, ells, tees and fittings to be S. A. E. standard, approved by the inspection department. The method of connecting leads shall be approved by the inspection department. All fittings shall be readily accessible for inspection, adjustment, repair, or removal.

ACCESSORIES TO POWER PLANT

Self starter.—A suitable self-starter shall be installed for each engine. The design, material and workmanship of this starter shall be such as to render its action positive and reliable under various service conditions. The self starter arrangement shall be approved by the Officer in Charge of the Aviation Section, Signal Corps, U. S. Army. The self starters shall be so arranged or so be conveniently operated from the pilot's seat. Self-starters shall be operated either electrically or by compressed air. Electric self-starters are greatly preferred if developed to a satisfactory degree. If the self starter equipment be electrical the weight of the entire equipment for both engines shall ...

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Aeronautical Patents

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News of the Fortnight

Army News and Announcements

The Aviation section of the Signal Corps, U. S. A., has advertised for bids for about 100 hydroaeroplanes and has issued the specifications under which these planes will be purchased. The estimated cost of the army's hydroaeroplane service is $2,000,000. This sum, added to the $3,000,000 worth of contracts for 175 land machines of all types already outstanding and the 100 school machines for which manufacturers have already entered their bids, estimated at $1,000,000 in value, makes a total of $6,000,000 worth of army business which has already been placed, or will be placed in a few days.

Photo by Aero News Service
MAJOR B. D. FOULOIS

A division of the Aviation Section has recently been organized to develop lighter-than-air types of aircraft, including free, captive and dirigible balloons. Major Charles de F. Chandler has been placed in charge of this work, and bids have been advertised for four army balloons, two spherical and two kite balloons. Fort Omaha, Neb., is likely again to become the center of army ballooning. A structural steel hangar large enough to house a dirigible 200 feet in length was erected there in 1908-09, and equipment for production and compression of electrolytic hydrogen was installed. Akron, Ohio, is also being considered as a possible center for army ballooning activities. Officers of the regular service interested in this branch of aeronautics have been requested to make application at once to the War Department for assignment to this duty.

The recruiting problem for the regular army's air service is also being given energetic consideration. A force of 148 officers and 1200 enlisted men is allotted to the army by the National Defense Act. At present the army has forty-five junior military aviators and a tactical staff of six officers, as well as thirty-eight student fliers at San Diego. The San Diego school is turning out junior military aviators at the rate of about eight a month. Besides the regular officers, the Army is allowed an unlimited number of Reserve Military Aviators, who will receive instruction at the expense of the service. Every effort is being made to secure applications for service with this attractive arm.

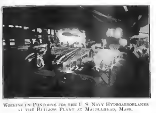
MAJOR FOULOIS TO COMMAND NEW AERO SQUADRONS.

Lieut. Col. Squier has signed orders for the formation at San Antonio of two new aero squadrons for the army, and for the purchase of the complete equipment for them. Major Benjamin D. Foulois, who is in command of the First Aero Squadron at Columbus, N. M., will organize the new Second and Third Aero Squadrons at San Antonio. The cost of their equipment will be approximately $1,600,000. Orders have been signed for the purchase of 24 tractor aeroplanes for these two squadrons.

The Army will train officers in flying at San Diego, where it has eleven training machines, which are to be increased by eighteen hydroaeroplanes. There are six machines at the Mineola training school on Long Island, and twelve under order for use there. There are four machines at the Chicago training station and twelve ordered. The Army bill appropriated $300,000 for purchase of land in California for aviation school purposes and $300,000 for another large tract. A special board is now considering the selection of the second site in the East.

Officers to Investigate Radio-dynamic Torpedo

Lieutenant Sheppley W. Fitzgerald, U. S. A., will operate the aeroplane to be used in the testing of the John Hays Hammond, Jr., wireless controlled torpedo this month. The torpedo will be put through tests before a board of Army and Navy officers, and if successful will be purchased for the United States Government.



WORKING ON PONTOONS FOR THE U. S. NAVY HYDROAEROPLANES AT THE BURGESS PLANT AT MARBLEHEAD, MASS.

Aero Club of Pennsylvania

Robert Glendinning, a prominent member of the Aero Club of Pennsylvania and president of the Philadelphia School of Aviation, flew his flying boat from the Essington School waters to the League Island Navy Yard, to deliver a pilot's license to Mrs. Robert Lee Russell, wife of the commandant of the yard. Mrs. Russell has been quietly taking lessons from the instructors of the school, and a short time ago passed the required tests necessary to obtain an aviator's license.

Mr. Glendinning left New York on the steamship *Espagne*, October 14, for France, where he will make a short stay, studying the methods used in the aviation schools of that country. He will not visit the war lines to see the airmen in action, his object being to see how war aviators are turned out at the schools, what methods are most efficient and to study the work on a large scale. What he learns there it is expected will be of invaluable assistance in the conducting of the Philadelphia school. As a competitor for the Curtiss marine flying trophy of $5,000, about a year ago, Mr. Glendinning covered a course in his flying boat of 160 miles in three hours.

George C. Thomas has also received his pilot's license from the Essington School, passing his tests on October 9. This is the eighteenth pupil graduated by the Philadelphia School of Aviation since it was organized last May. The school will close on November 1 for the winter. From the opening until October 6 Walter Johnston, chief instructor, was in the air 10,515 minutes, and his longest flight was six hours in a day. The school equipment at the present time consists of two hydroaeroplanes and one flying boat.

Trade Note

An investigating committee of the British Government recently reported in favor of linen for fabric to cover aeroplane wings. It was found that an unbleached cloth, weighing 4 ounces to the square yard, and having a minimum strength of 92 pounds per inch for the warp threads and 95 pounds per inch for the weft threads, would stand up to all the severe tests which the Royal Aircraft Factory imposed upon any linen fabric which they might specify for use in their planes.

So far no other fabric but linen has stood so well the severe strain to which the wings are subjected, and the leading manufacturers here, as well as the United States Government, have followed pretty closely the British specifications. Several of the well-known Irish linen importing firms have been able to secure large supplies of the right class of linens, and can make immediate deliveries.

Before the linen could be got out of Ireland a special license had to be procured by Robert McBratney & Company, 121-123 Franklin Street, New York, from the British Government, as it was very much averse to letting any fabric be exported which is used in such large quantities in its Air Service.

Lawrence B. Sperry Returns from Boston

Lawrence B Sperry brought his aeroplane back from Boston to Amityville in the same way in which he took it East—by the air route He started from Marblehead on Monday afternoon, October 23, and landed at Brant Rock about thirty miles from Boston where he stayed overnight, as he figured that he could not make New York before dark

He started from Brant Rock with Robert Fowler as passenger at five minutes after one o'clock on the afternoon of October 24, and flew without stop to Amityville, where he arrived at ten minutes after four o'clock having covered about 200 miles in 185 minutes He used an 85 horse-power Curtiss flying boat, equipped with the Sperry automatic pilot

The start was witnessed by Lieutenant S. W Fitzgerald, U. S. A., and other officers of the army and navy Mr Sperry carried fifty-five gallons of gasoline, weighing about 120 pounds He also carried a complete set of scientific instruments, life preservers, lights, compass, and an especially made chart mounted on two rollers, to facilitate handling it.

The boat used was a Curtiss model F built two years ago. The fact that Mr Sperry was able to cover 200 miles in about three hours in it part of the time through a nasty quartering storm, speaks well for this machine Modern aeroplanes should be able to make even better performances

The Navy Is Awaiting Its Paul Schmitt Aeroplane

The United States Navy is awaiting delivery of a hydroaeroplane built by the Paul Schmitt Aeroplane Company This machine is to be shipped to the United States at once where it will be used for experimental purposes The aeroplane has a wing of variable angle of incidence which the Navy Department desires to investigate

Domestic Exports of Aeroplanes

According to Special Monthly Statement Number 41, just issued by the Department of Commerce, two aeroplanes were exported from the United States in August, valued at a total of $24,000

Massachusetts to be Presented with Aeroplane

On November 8, in the afternoon, the presentation of the tractor biplane given in the name of the Aero Club of New England to the State of Massachusetts will take place at the Massachusetts Institute of Technology by courtesy of President Richard C Maclaurin

Governor McCall will accept the aeroplane on behalf of the State, to be used for the training of the Massachusetts Naval Militia in the art of flying, after the presentation speech has been made by Godfrey L. Cabot, president of the Aero Club

For the first time in the history of Massachusetts, an aviation tour of duty has just been held at Mystery Island in Salem Harbor, and this machine was completed and began its flights during that tour

The Aero Club of New England hopes that from this modest beginning a great movement may be started which will bring forth better defense in the air, and that by the first of the coming year five aeroplanes in Massachusetts will be devoted to the training of military aviators

President Cabot of the club has flown as a passenger in the machine, and is enthusiastic over its performance.

Norman Prince Is Dead

Norman Prince, a Harvard graduate and the best known of the American fliers serving with the French Aviation Corps, and who was several time decorated for brilliant work in the air, has died from injuries sustained a few days ago

Prince entered Harvard in 1905 completed the course in three years and in 1911 was graduated from the Law School In the latter year he showed a marked interest in aviation, and under the assumed name of "George H. Mannor" he began training By the time he was starting his flights at Squantum after training at the Wright School in Georgia he was unable to keep his identity secret

In December, 1914 Norman Prince and Frazer Curtis decided to offer their services to France. They assembled around them several young Americans—James Bach Elliot Cowdin, H G. Gerin, Bert Hall, D G Masson James McConnell, Andrew Ruel and William Thaw most of whom were students of American universities. Their certificates obtained, they served for a time in the aerial defense of Paris, after which they were sent to the front William Thaw obtained the rank of sub-lieutenant in action He was specially mentioned in despatches, as were Sergeants Elliot Cowdin and Norman Prince

Last July Prince participated in a thrilling battle between American and German fliers, in which the latter were worsted The Americans had made a sortie over the Teutons' lines and were met by the enemy's aircraft The two American machines had been attacked when Prince went to their assistance. At the same time a German "aviatik" rushed into the fight on the other side. Every one of the American machines was hit several times Finally the German machine which was trying to make observations, was obliged to retire, and the "aviatik" quickly fled

On another occasion Prince was making an observation trip over the German lines when his motor stalled, and, although he was the target for German anti-aircraft guns, he succeeded in volplaning back into French territory Landing near a battery, he was invited to take luncheon with the officers. He later notified the commander of the aviation squad that he had not been lost and was safe and sound

One of the daring exploits of Prince was when he brought down a German "sausage balloon," one of those used for observations In order to accomplish this task he had to fly low and within easy range of the German guns Prince had a special weapon for this attack, and, going within three hundred feet of the balloon, he had the satisfaction of seeing it blow up and sink.

Prince's courage and spirit won for him in France highly prized decorations. He was several times decorated once with the Croix de Guerre, for bravery, and just before he died, in the hospital, with the Legion of Honor medal He won his first medal, the War Cross of the French Republic, which corresponds to the German Iron Cross, for destroying a German war plane in an aerial battle over Verdun He held the rank of sergeant in the Corps

THE SHIPPING ROOM OF THE HALL-SCOTT MOTOR COMPANY

Mineola News and Notes

The Army aviation station at Mineola, N. Y., has over seventy men actually in residence at the present time. Of the 1st Aero Co., N.G.N.Y., mustered out on September 23rd, 36 men and 1 officer were retained by special permission of the Secretary of War. There are 10 militia officers from various states and a detachment of 25 regulars, including the Quartermaster Corps. The camp is in charge of Lieut. J. E. Carberry, U.S.A., and with him are Lieuts. Kilner and Rader.

It is likely that the men of the 1st Aero Co., N.G.N.Y., will be mustered out on October 31st and returned home. Several of these, however, may be recommended to be sent to San Diego, Cal., for advanced flying and remain there all winter.

The list of men who are receiving flying instruction includes seventeen men who are flying alone, some of them well advanced. Seven men are receiving instruction and six civilian applicants for positions as instructors are being tried out. The flying list is increased from day to day by the names of those men of the 1st Aero Co. who were mustered out, to whom the privilege is granted of coming down to the camp for a flight or for instruction whenever possible. The present instructors are Bounds, Milhman, and Allan.

The camp now has ten Curtiss JN-4 machines, one of which is about to be replaced, as it has been worn out in service. There are three Standard Aero Corporation planes at the field which are to be turned over to the government in a few days, also an L.W.F. triplane, with a 135-horsepower Thomas motor to be tested. The machine of the Eastern Aeroplane Co., with an eight-cylinder Maximotor, has been making flights at the field also.

EXPERIMENTS IN SIGNALLING

A number of experiments have been made with bombs designed for illumination of the ground and signalling to observers at night. Mr. Allan, with Lieut. Wheaton of New York in the observer's seat equipped with a number of magnesium bombs, went up to an altitude of 2500 feet at night. Lieut. Wheaton dropped the bombs, which were plainly visible from the ground, and the experiments were considered highly successful. With the same men in the machine, smoke bombs were tested for daylight use with the same satisfactory result.

Lieut. Carberry, with Mr. Emil Simon in the observer's seat, flew at night to test an electric searchlight, designed to aid the pilot in landing. The power for this searchlight is generated by means of a fan placed under the fuselage.

Sound signalling with a huge Klaxon horn has also been tried both for day and night flying. The Klaxon was heard distinctly from over 6000 feet in the air.

RADIO TESTS AT THE FIELD

Radio tests have been conducted with the Sperry small radio set and communication established with the base on the ground. The tests with Dr. De Forest's radio set were not completed, owing to the necessity of sending it to the Navy Department at Washington.

A dictaphone was set up in one of the machines and tried out, but the results were unsatisfactory, due to the noise from the motor. It is similar to the commercial instrument, to be used by the pilot and observer in recording information of the country over which he is flying.

Orville Wright is Flying Again

Orville Wright is flying at Dayton, Ohio, practically every day. For the first time in two years the man who with his brother won the right to be called "fathers of flying" has resumed his practical work in the air. On one afternoon recently he made more than a dozen flights.

Mr. Wright has also confirmed the story that no effort will be made to renew his British patents upon their expiration early in 1917.

"I don't think it is possible to renew our patent rights in other countries," he said, "and therefore it would be unfair to England to ask a renewal there.

"Patent rights in England are short-lived and our rights in that country expire before any others. This naturally means that the rights may, under British law, be taken up by machine-makers there. However, machines made under such rights cannot be marketed outside of England."

New shock absorber fitting designed by Charles H. Day for model H-3 Standard Aero Corporation machines. While the fitting looks clumsy, the head resistance is not excessive and the advantage of having a shock absorber in which the rubber bands are not crossed and cannot chafe is considerable.

Classified Advertising

10 cents a word, minimum charge $2.00 payable in advance. Positions Open or Positions Wanted advertisements no charge (20 words). Address replies to advertisements with box numbers, care of AVIATION AND AERONAUTICAL ENGINEERING, 120 West 32d Street, New York.

AGENTS wanted in every city for AVIATION AND AERONAUTICAL ENGINEERING. An especially liberal offer is open for the months of September and October. Address Circulation Managers, AVIATION AND AERONAUTICAL ENGINEERING, 120 West 32d St., New York.

YOUNG MAN doing exhibition work, desires to learn aviation. Address Box 8.

EXPERIENCED YOUNG AERONAUTICAL ENGINEER desires position as assistant or in charge of experimental work. Small live company preferred. Address Box 14.

CHAS E MULLER, draughtsman, please communicate with M Greenwood, 42 Broadway, New York.

$635 gets 6-cylinder 85 horsepower Aeromarine motor taken for debt. Identical with motor used by Art Smith. Double oiling system. 2 independent magnetos. In excellent condition; recently overhauled at Aeromarine factory. Address, Box 6.

YOUNG MAN experienced on aerial engines seeks position with reliable concern manufacturing Aircraft. Wants instruction in flying. Address, Box 47.

YOUNG MAN with good habits, machinist, desires position with reliable aeroplane company, to learn aviation and become aviator. Address Box 21.

YOUNG MAN desires position with aeroplane company to learn aviation, understands gas engines, is a mechanic. Address, Box 32.

ENERGETIC YOUNG MAN desires position with aeroplane company to learn aviation and know all parts of aeroplanes. Address Box 24.

FOR SALE—Single passenger training biplane equipped with 3 cylinder 35 H. P. Anzani motor. Motor and plane both brand new. Ideal equipment for beginner to use as penguin or for short flights. Can be seen at U. S. Army aviation field at Mineola. Property of 1st Aero Company. U. S. Government desiring to standardize equipment for school work did not take over this plane, which is in perfect condition. Address Box 5.

HOW TO UNDERSTAND AEROPLANES, by S. L. Walkden. Fourth edition enlarged. Contains exclusive matter. 40,000 sold. 125 pages. 88 figures and illustrations. Price $1.00 postpaid. W. E. Walkden, 2969 Fifth St., San Diego, Calif.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, of AVIATION AND AERONAUTICAL ENGINEERING, published semi-monthly at New York, N. Y., 1st October, 1916.

State of New York } ss
County of New York }

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared Lester D. Gardner, who, having been duly sworn according to law, deposes and says that he is the President and Editor of the Gardner, Moffat Co., Inc., Publisher of Aviation and Aeronautical Engineering, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business managers are:

Publisher, The Gardner, Moffat Company, Inc., 120 West 32nd St., New York, N. Y. Editor, Lester D. Gardner, 120 West 32nd St., New York, N. Y. Managing Editor, Herbert S. Williams, 120 West 32nd St., New York, N. Y.; Business Manager, Lester D. Gardner, 120 West 32nd St., New York, N. Y.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)

The Gardner, Moffat Company, Inc., 120 West 32nd St., New York, N. Y.; Lester D. Gardner, 120 West 32nd St., New York, N. Y.; William J. Seaman, 20 Exchange Place, New York, N. Y.; William D. Moffat, 52 East 19th St., New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

LESTER D. GARDNER

Sworn to and subscribed before me this second day of October, 1916.

[SEAL.] MANGHILD A. LINDBLOM

My commission expires March 30, 1918.